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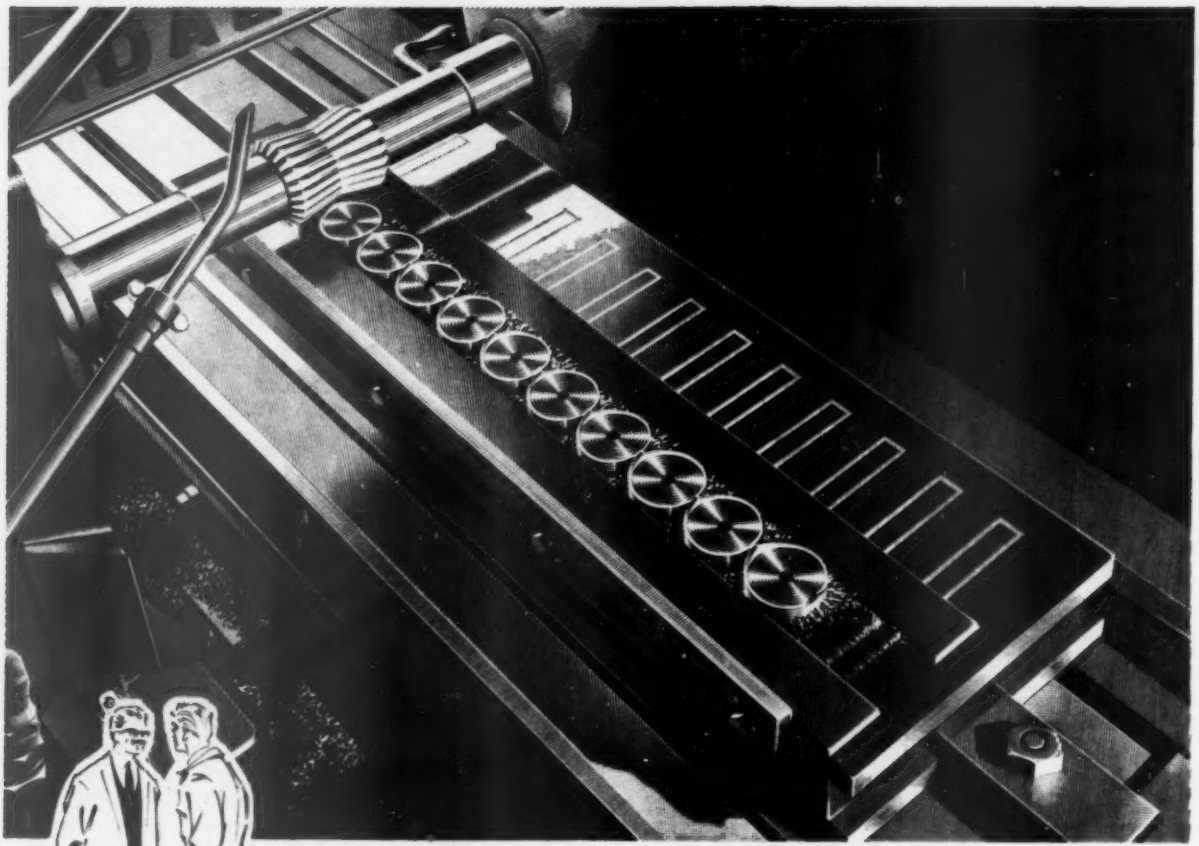

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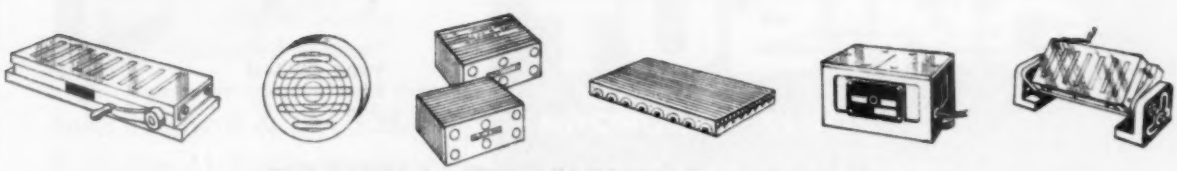

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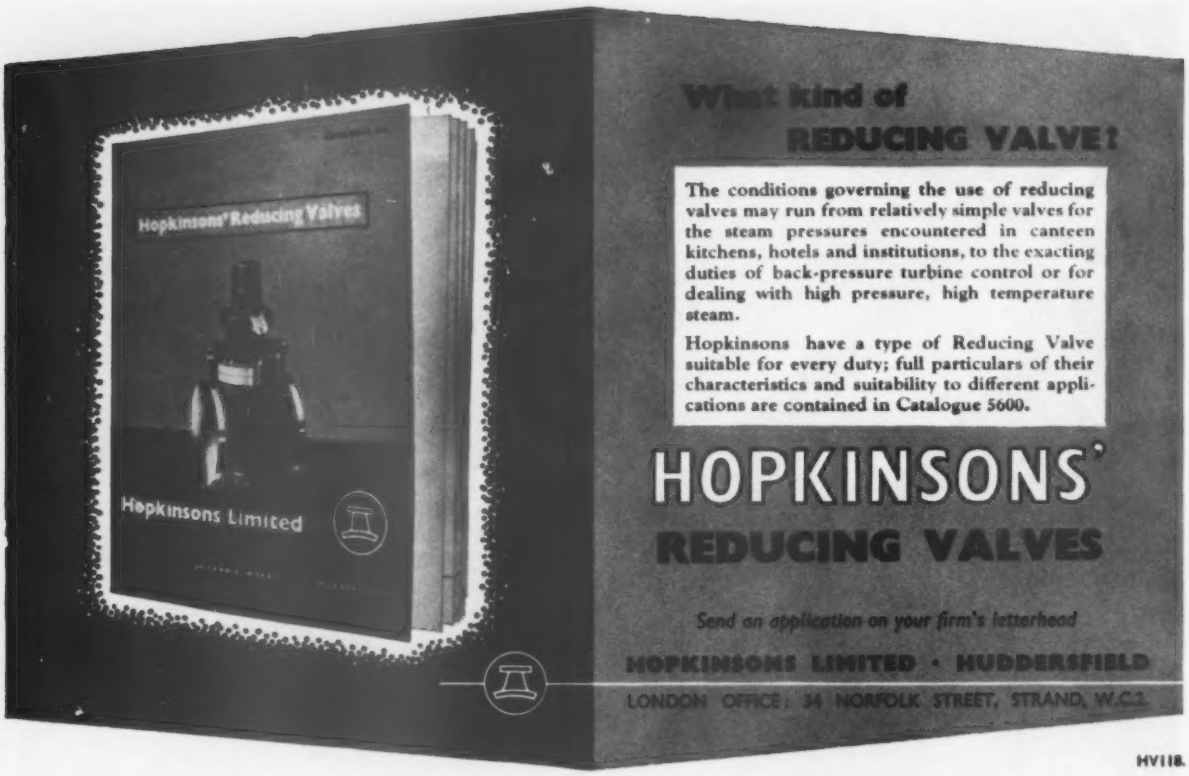
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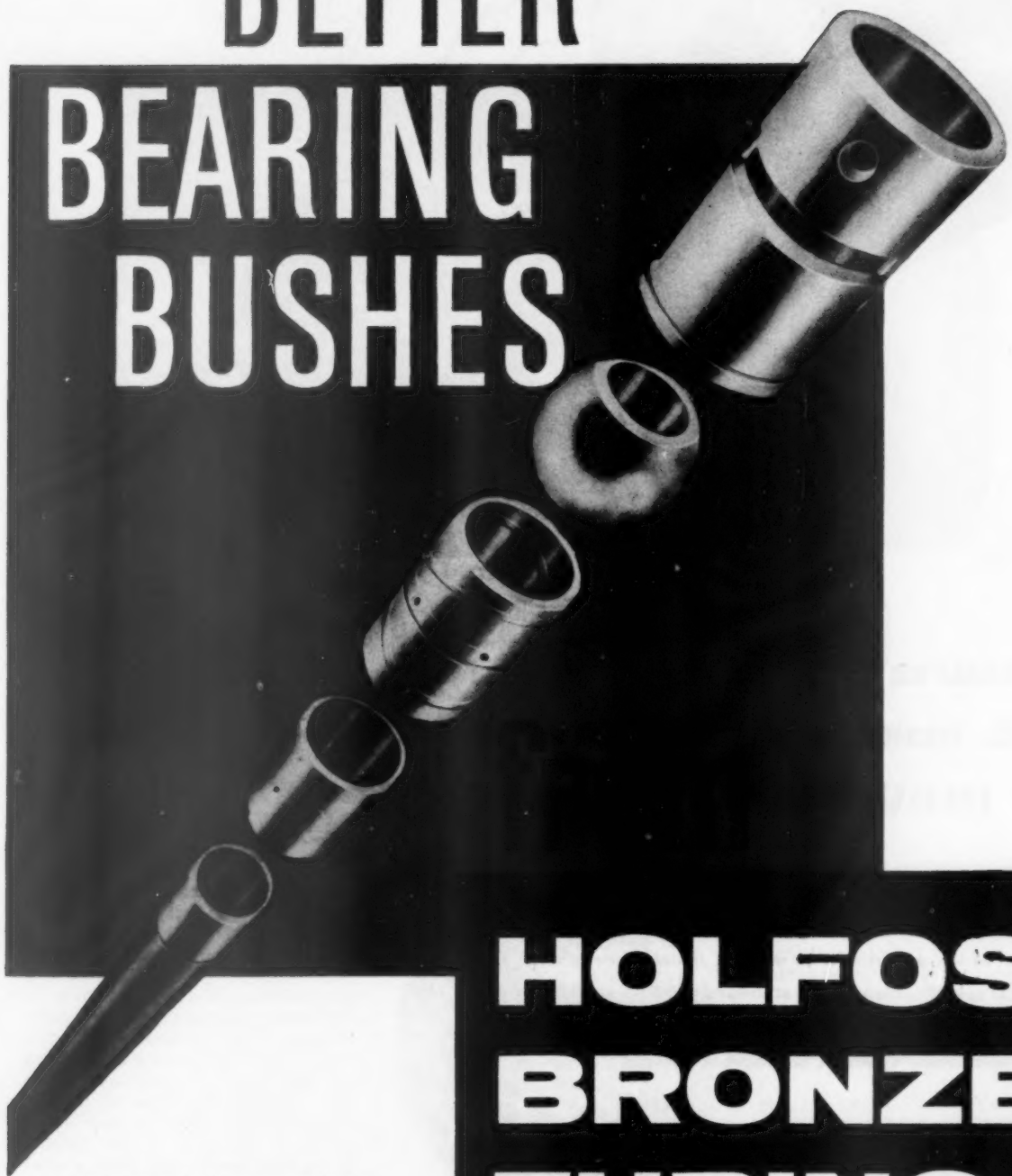

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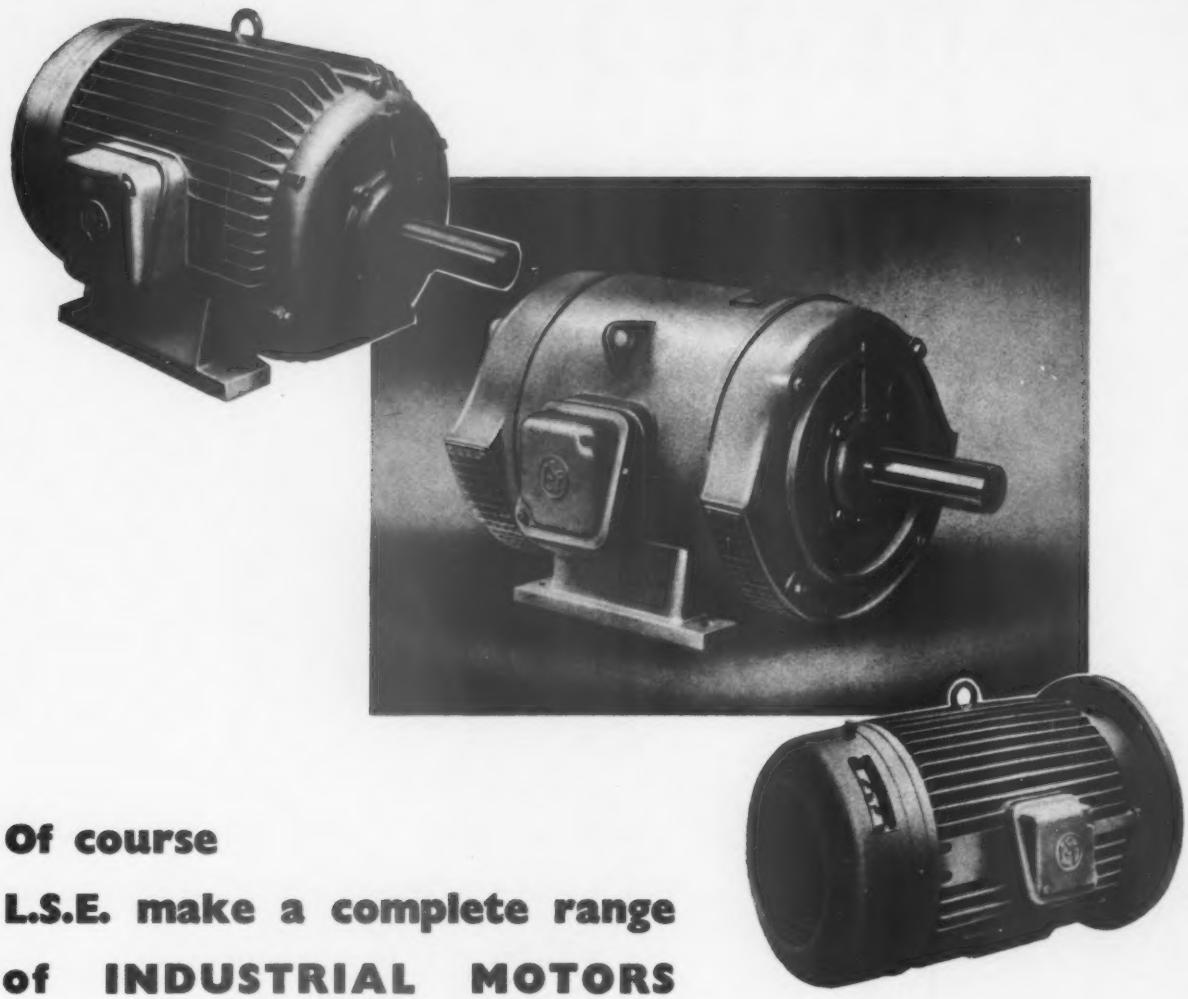

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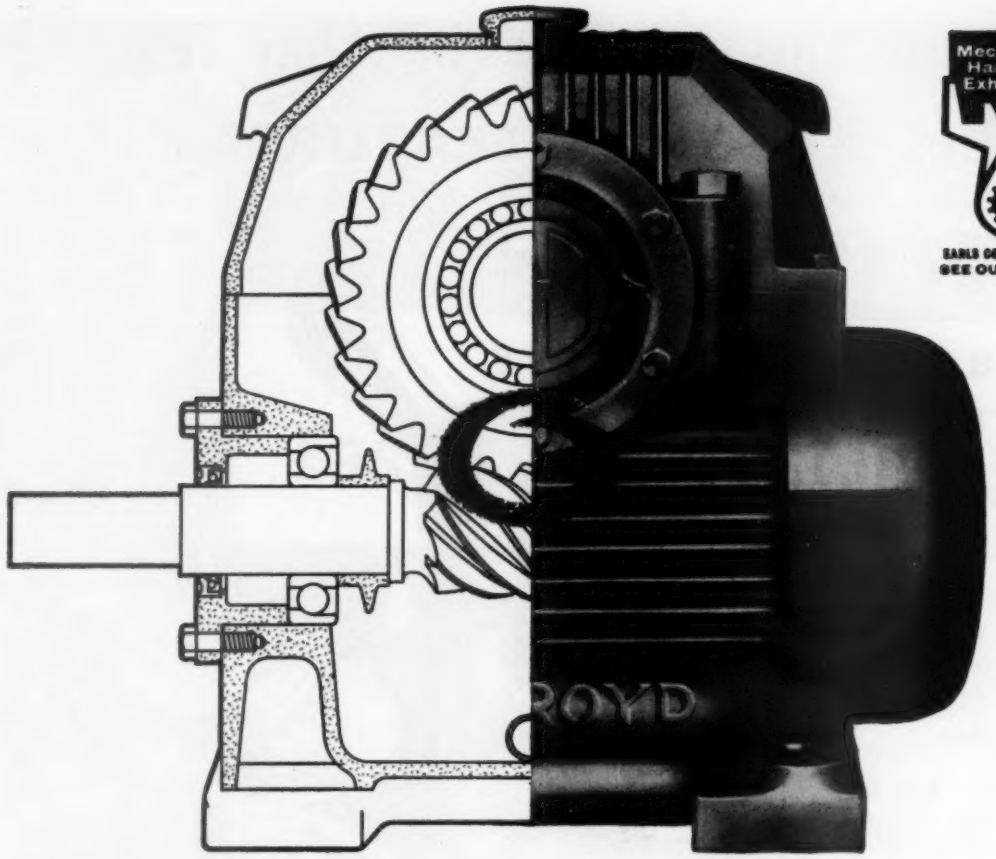

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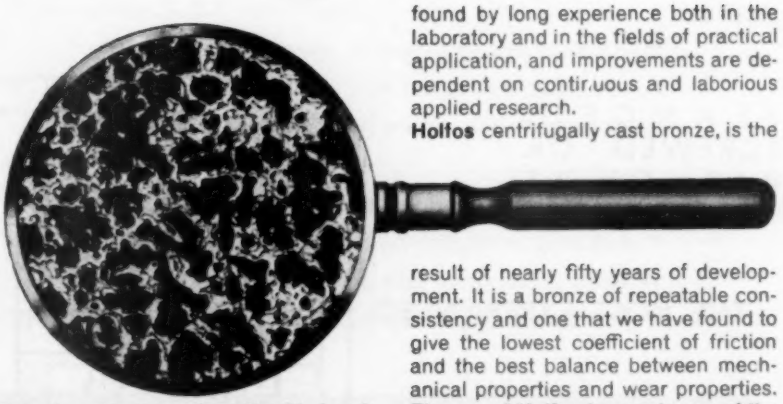

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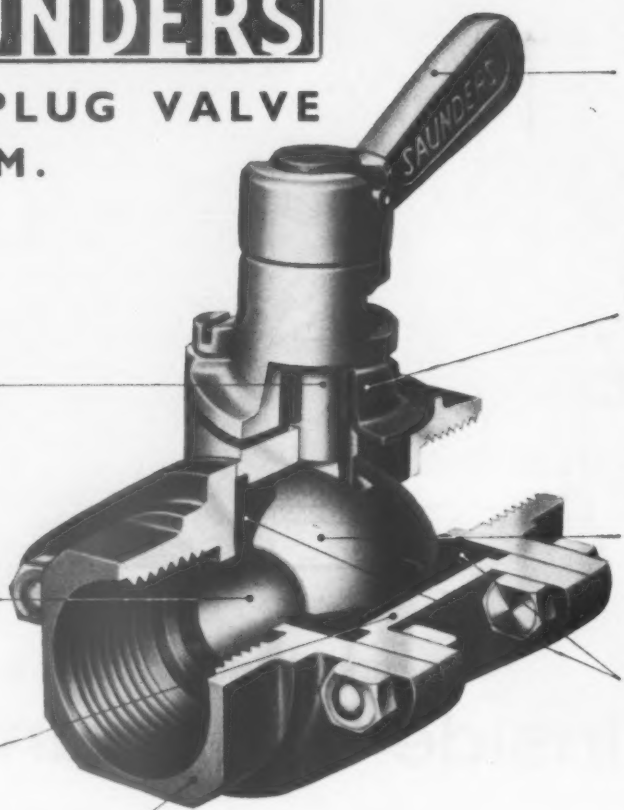

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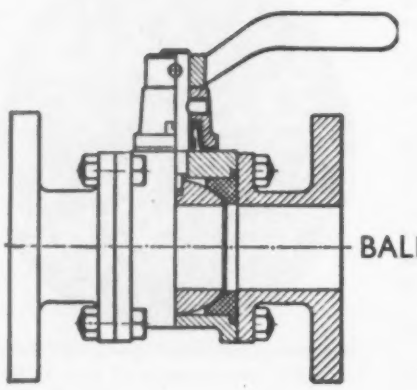

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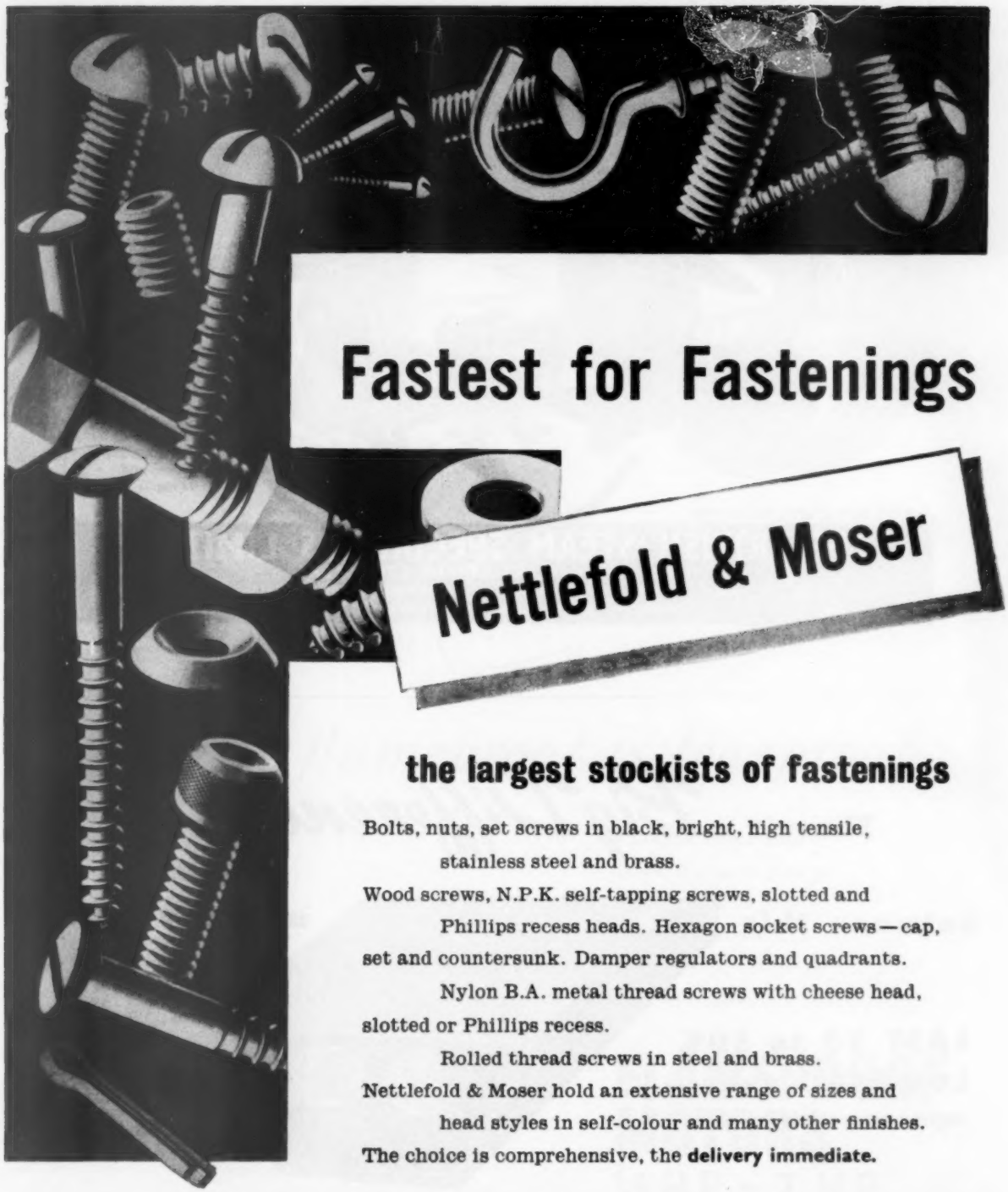

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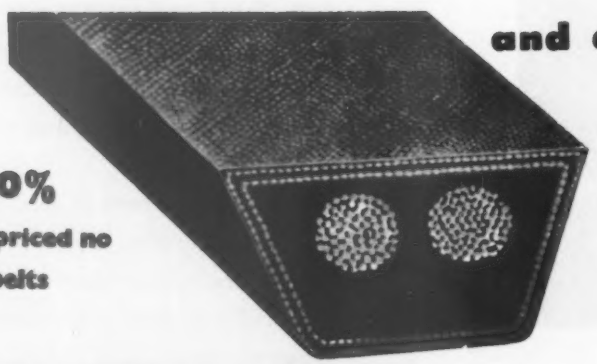

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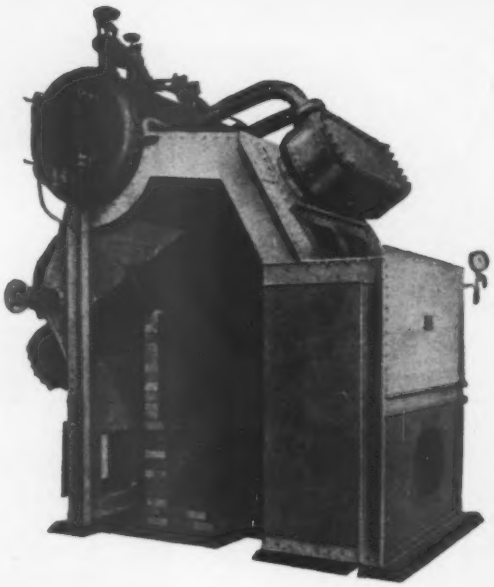

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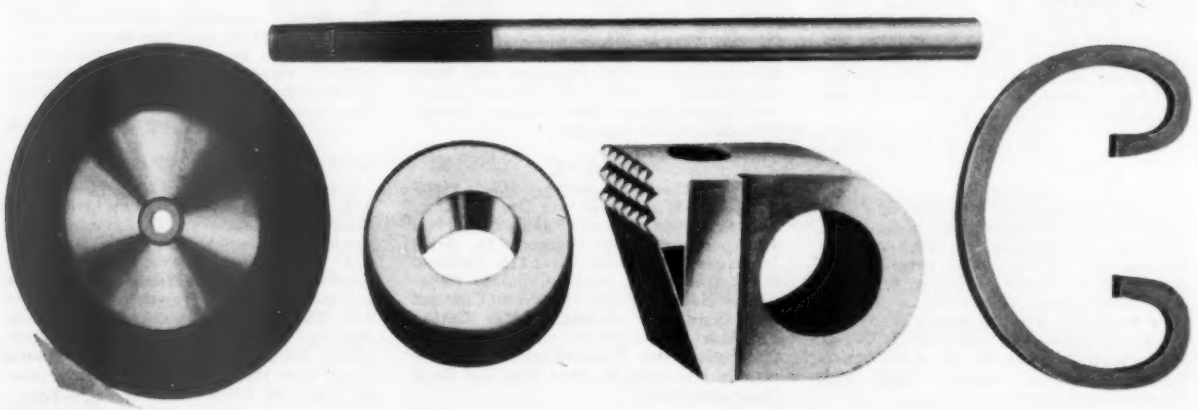

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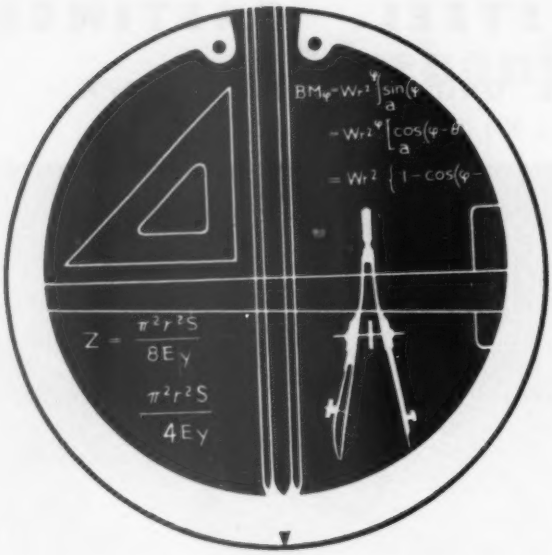

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Mechanical World

AND ENGINEERING RECORD

Vol. 142 MAY, 1962 Number 3514

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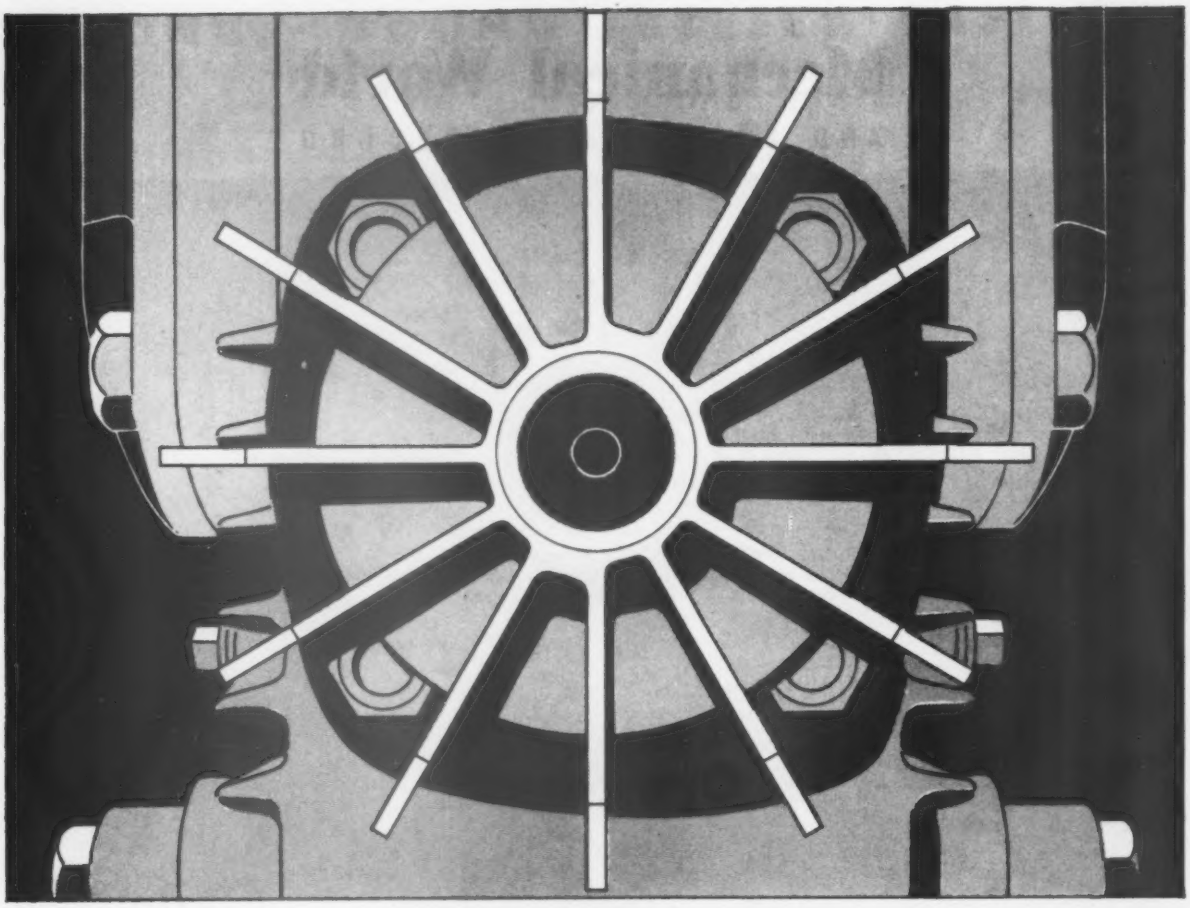

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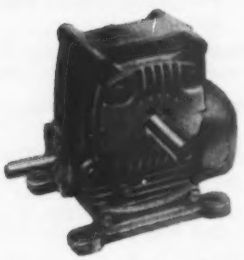

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Mechanical World ——— May 1962

Throughput

TIME means money in the factory, whichever way one looks at it. From the customer's point of view time means the delivery date, and is ideally the occurrence of requirement within his own programme; if the programme has to be constructed to suit delivery then economy is not always so well served. The perfection of timing is afforded by "buying off the shelf", which is common for a wide range of products and is determined by the possibility of standardization and continuity of sales in sufficient volume to allow of either continuous or batch manufacture. The next best thing is the delivery schedule, which is quite common for standard designs, and even though no finished stock is carried, the certainty of delivery in the minimum time corresponding to advanced manufacturing technique endows the product with an air of prompt availability.

The distinguishing feature of this picture of a characteristic relationship between a style of manufacture and a customary availability of the product is the indentification of the product with its maker—a ship from a shipyard, a boiler from a boilermaker, an engine from an engine builder, a tool from a toolmaker, a bridge from a bridge builder, and so on. Any work not describable under one or other of these numerous specialist headings falls into a large and venerable group, that very cradle of ingenuity known as "general", which in engineering has the tradition of "making anything"—in practice perhaps not quite so all embracing as this term might imply, but certainly encompassing work of the most remarkable variety. Establishments in this category are probably the most numerous of any group and of the greatest range of size, from the one-man shop to some of the finest general shops in the world—the maintenance departments of the first magnitude industrial plants.

The general shop exists by getting the work done adequately and on time, the latter often being the main factor. In varying economic fortune it has at times barely survived and at others prospered because it offered a way of life to those to whom the craft meant a lot more than just a livelihood. For a time and by contrast the economy of mass production overshadowed and sometimes depressed the one-off trade, but the possibilities are very different today. The most modern machine tools employing the coordinate principle and other devices will do a one-off job with very nearly the same facility, accuracy and cost as a long run, consequently a well-equipped shop (inevitably highly capitalized) with an organization to match can cope with the utmost variety of kind irrespective of repetition, and with only one proviso—that there is enough of it, because the heavy capitalization demands continuous employment.

In its most advanced forms, therefore, engineering manufacture has been divested of some of the economic differential between specialization and general work and has become more a matter of grouping facilities to suit the available trade. The remaining common factor is the use of time, and this increases in importance with the intensity of capitalization. With full utilization of time everything else—wages, conditions, profits and general development—becomes possible. Uninterrupted throughput comes first. Dispute and argument can be left for the benefits that accrue from it, but the source must not be disturbed.

LOG SHEET

Germanium Rectifier Plant

The 3½ MW Westinghouse water-cooled germanium rectifier equipment at Richard Thomas & Baldwin Limited, Ebbw Vale, supplies the d.c. power for plating (180,000 amp), pickling (15,000 amp), cleaning (20,000 amp) and chemical treatment (5000 amp). Overall efficiency from 11kV input to rectifier output is in excess of 90% and the power factor at full load is 0·83.

The equipment, which was supplied as a sub-contract from The Head Wrightson Machine Company Limited, includes 11kV/600V step-down transformers, a.c. switchboards, transductor cubicles, transformer/rectifier sets, control gear and reversing switches. The transformers, consisting of 4×1250kVA for plating and one 1950kVA for cleaning etc., and 440V auxiliary supplies, are situated in three-sided brick pens adjacent to the main a.c. switchboard room.

The a.c. switchboards handle 600 and 400 V, three-phase a.c. and 230V d.c. auxiliary supplies. Each of the twelve plating tanks has a top and bottom anode, plating the top and bottom sides of the strip. One rectifier set supplies each anode, and the plating switchboards are divided into 24 sections, one per set. Any combination of top and bottom plating sets may be used. Three-phase 600 V lines feed each transformer/rectifier set.

Plating current control to within 5% is obtained by amplifying a tacho-generator signal through four magnetic amplifier stages. The overall accuracy of better than one per cent is achieved by a closed loop correction system. A separate tacho-generator signal is compared to the D.C.C.T. current signal, and the difference is amplified to provide correction control on the penultimate magnetic amplifier stage. A fault in the correction system could, at the worst, only introduce an error of three or four per cent. Apart from one stage of the correction amplifier, no valves are used at all, the entire control system utilizing static magnetic amplifiers.

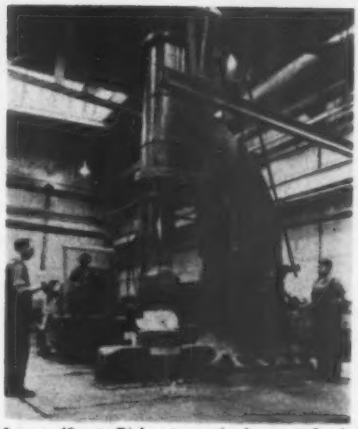
Control is from the line operating platform, where master controls are provided for setting strip width and coating weight, while two pre-set controls afford compensation for changes in plating efficiency and drive bridle roll diameter.

PRESSURE VESSEL JACKET.—Grinding the spacer bars of a pressure vessel jacket at the Greenwich Works of G. A. Harvey & Co. (London) Limited. Seven stainless steel pressure vessels, 6ft 6 in. dia are being manufactured to the design and order of a customer. Each fits closely inside a mild steel jacket of the type illustrated which has 1½ in. wide spacer bars arranged in a helix. In operation, hot water is fed into the jacket, the baffles ensuring even distribution of heat to the vessel contents

Metalastic Silver Jubilee

The two main factors in the growth of Metalastik Limited have been, first, the tremendous advance in mechanization during the last 25 years coupled with the readiness of manufacturers to adopt the effective and economic means of controlling vibration placed at their disposal, and second, the economic necessity of reducing maintenance and repairs to a minimum. Metalastik components are now widely used in automobiles, railway rolling stock, aircraft, in numerous marine applications, in civil engineering and in many electrical applications.

Metalastik Limited of Leicester, who designed and manufacture, among many other bonded rubber components, the suspension springs for London Transport trains and the Midland Red motorway express coaches, celebrate their Silver Jubilee this month. The company was established in 1937 by Mr. M. Goldsmith in conjunction with the John Bull Rubber Company to exploit the technique of bonding rubber to metal. Backed by excellent research work, progress was rapid. The company was the first in Great Britain to manufacture components in which rubber was controlled for dynamic and static moduli and the first to test every component for dynamic stiffness. At every stage of manufacture, from the compounding of rubber to final inspection, the quality of Metalastik components is checked physically and dynamically. Special machines have been developed and built by the company for fatigue testing.



Massey 40 cwt Rigby type air hammer forging titanium ingots at I.C.I. Metals Division, Birmingham

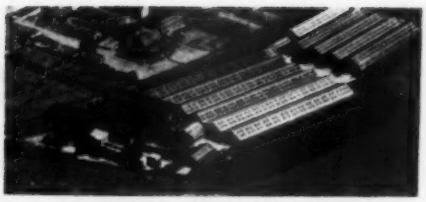
Forging Titanium Ingots

In the titanium plant at the I.C.I. Metals Division, Birmingham, large 20-in. dia ingots are preheated in electric resistance wound furnaces and initial reductions carried out on a forging press. At an intermediate stage, orders are completed on a Massey 40-cwt Rigby air hammer by hand manipulation, a diesel driven manipulet or an electro-hydraulic manipulator, depending upon the size of product. Preheat temperatures for some titanium alloys are very low, verging on black heat; in these circumstances, the forging hammer can be a most useful tool, there being less likelihood of internal bursting on small section bar than if it were forged on a large forging press. In addition, alloys developed for good creep strength can be successfully worked on the hammer.

The Rigby hammer is also used for forging evaluation ingots of 'new' metals such as hafnium, niobium, and tantalum, where the least possible contact with tool surfaces is desirable.

I.C.I. titanium has two main outlets—the aircraft industry and the chemical industry. In aircraft, titanium, with its high strength/

Left, Crofts original workshop—1878. Above, head office and main works, Thornbury, Bradford, Yorks. The company celebrates its 75th anniversary this year



No. 2 Works, Dudley Hill, Bradford.

weight ratio and retention of properties at elevated temperatures, is used for fireproof bulkheads, exhaust shrouds, compressor blades, discs, casings and by-pass ducts, forgings, bolts and other fasteners. In the chemical industry where the outstanding corrosion-resistance of titanium is of great importance, applications vary from heat exchangers, pumps, tanks and distillation columns to heating coils for plating plant, and anodizing jigs.

Crofts 75th Anniversary

Crofts (Engineers) Limited, of Bradford, Yorkshire, are this year celebrating their 75th Anniversary. The company, which has contributed to the development of every industry, both at home and overseas, has achieved a world-wide prominence by specialization—from the beginning Crofts have devoted their undivided attention and resources solely to the production of power transmission equipment.

The company had a modest beginning. The first workshop employing only seven people was opened in 1887 by the late Mr. Frederick Lister Croft to manufacture his patent wrought iron pulley and other general gearing used in the booming woollen mills of the West Riding. The years that followed were a period of rapid growth and expansion and the comparatively young enterprise began to cater for other industries and by 1898 the volume of business was such as to demand new premises. Land was acquired at Thornbury, Bradford, with adequate space for immediate needs and which was large enough to allow for future expansion. The head office and main works are still on this site and development is still in progress.

With the building of these new premises, the company formulated its policy of manufacturing products through all the stages from rough casting to finished unit in one co-ordinated organization. Iron and non-ferrous foundries, pattern shops and stores were constructed and the first melt was poured in 1904.

Through the years, Crofts have added a steel foundry and machine and assembly shops. Development has been continuous and the resources of the company have been considerably extended in recent years so that they now cover an area of some 35 acres, comprising two major works in Bradford. More than 4000 people are employed by the Crofts organization.

The design of the majority of the company's products is such that they can be manufactured in a wide range of sizes and capacities completely standard in design and materials. This simplifies production and has resulted in speedy manufacture. Productive capacity is not limited to standard products, however, and the company undertakes many jobs of a one-off nature. Each of the sixteen branch offices operates a technical liason service designed to study any power transmission problem and to advise customers on the suitability of equipment for any job. Crofts also have associate companies in Canada, South Africa and the U.S.A. and elsewhere they are served by agents and distributors in every continent.

Mechanized Moulding

A new mechanized moulding plant installed at the works of R. J. Hunt & Son Limited, is designed to produce 50–60 tons of castings per week for the automobile, agricultural and general engineering trades, weighing from a few ounces up to 35 to 40 lb with a maximum output of 2000 moulds per eight hour day, from three pairs of British moulding machine BQI automatic machines and one pair of foundry equipment magnetic moulding machines, all served by a box return pendulum-type conveyor, overhead sand hoppers with pneumatically operated doors and a completely gridded floor to remove overspilled sand from the moulding area.

The mould parts are taken by a closed circuit pallet conveyor towards the weighing and casting area at a speed which can be varied by a variable speed gear box and Vulcan fluid coupling.

The sand passes from the knock-out into the reconditioning system, the box parts being conveyed to the moulding machines and the castings to the dressing shop wheelabrator via an overhead cooling conveyor which travels outside the building where it forms two loops giving a total cooling time of 2½ hr.

Compressed air is supplied at 85/95 psi by 300 cu ft per min Alley & Maclellan reciprocating after-cooled compressors.

Lubrication of Roller Bearing Gears

The pressure at the nominal line contacts formed between gear teeth and between rollers and their races is typically 6000 atmospheres. Despite such a high pressure which opposes the passage of lubricant between the surfaces, the surfaces are separated by an oil film of thickness of the order of 1 micron and which is formed hydrodynamically.

A disc machine shown by Associated Electrical Industries Limited at the Physical Society Exhibition reproduces the kinematic conditions at the contacts of gear teeth and of roller bearings. It has been designed for quantitative studies of the hydrodynamic oil film including the effective viscosity of the lubricant within the region of high pressure. As shown it was arranged for the measurement of thickness of the hydrodynamic film and for the shape of the film in a section perpendicular to the axes of the discs.

Production of Components with Extruded Necks

The extruded neck for screw fastenings has to provide sufficient depth of metal for the thread and enough length to develop the full strength of the screw. Complete data are presented for producing necks to suit the principal screw thread forms in a range of sizes

By W. RICHARDS, A.M.I.Prod.E.

THIS article is concerned with extruded neck components required for subsequent tapping with BA and Whitworth threads. Some reference is also made to the 60° thread system. All the components considered have been produced—with results detailed in tables, charts and photographs herewith. Referring to Tables I and II, the examples are suitable for tapping with BA threads from size 0 to 8, inclusive. Table III similarly applies to the smaller BSF and BSW screw threads. Data given cover the tapping hole diameter (the diameter of the initially pierced hole) the outside diameter of the neck (material and its thickness) and the total height of the component, obtained when various initial diameter holes are provided in the blank.

The components were extruded in a tool of the type shown in Fig. 1. The tapping size is produced by the plunging punch (the outside diameter of the neck is given by the die) the bore diameter being governed by the thickness of the material employed. In operation, the material is stretched over the shaped end of the punch, closely hugging its surface, as shown at B in Fig. 1, but is comparatively free in the bore of the die. The blank is held flat and taut by the pressure pad indicated. During the plunging process, no material is drawn from beyond the bounding circle D, thus no drawing occurs over the edge of the die, which may be sharp at the junction of face and throat as indicated in Fig. 1. The inside surface of the initial hole d_1 becomes the free end of the extruded neck. Under these conditions a considerable amount of uncontrollable stretching occurs, and the material will obviously be of reduced thickness at the free end of the neck, as indicated at C in Fig. 1.

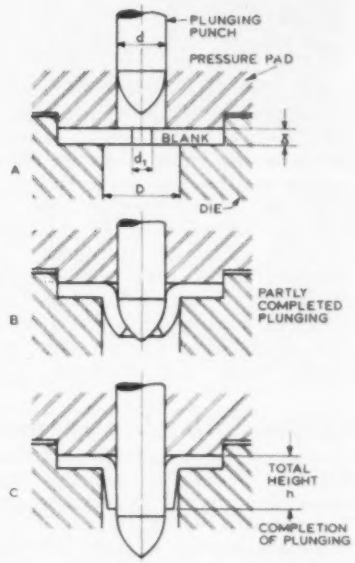


Fig. 1.—Type of tool used in the production of components —Tables I, II, III

For tapping purposes, therefore, it is essential to ensure a total height *h* of the component sufficient to provide the necessary length of the portion to be threaded, and at the same time the neck must not be extruded to such a degree that it becomes too thin at the open end to adequately provide for the depth of the screw thread. Referring to the Tables I, II and III it may be stated at

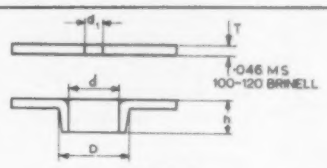


Table I

Component No.	Initial Hole d_1 Dia	Total Height h	Punch and Tapping d	Die and Max Neck Dia D	No. BA
1	0·098	0·124	0·204	0·300	
2	0·076	0·137	,,	,,	
3	0·055	0·148	,,	,,	0
4	0·046	0·158	,,	,,	
5	0·038	0·164	,,	,,	
6	0·087	0·115	0·184	0·275	
7	0·070	0·126	,,	,,	1
8	0·055	0·138	,,	,,	
9	0·038	0·147	,,	,,	
10	0·080	0·108	0·160	0·252	
11	0·060	0·122	,,	,,	
12	0·038	0·137	,,	,,	2
13	0·032	0·140	,,	,,	
14	0·070	0·103	0·140	0·233	
15	0·055	0·112	,,	,,	
16	0·038	0·125	,,	,,	3
17	0·032	0·132	,,	,,	

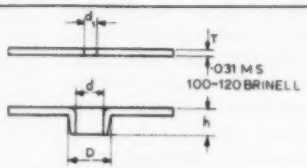
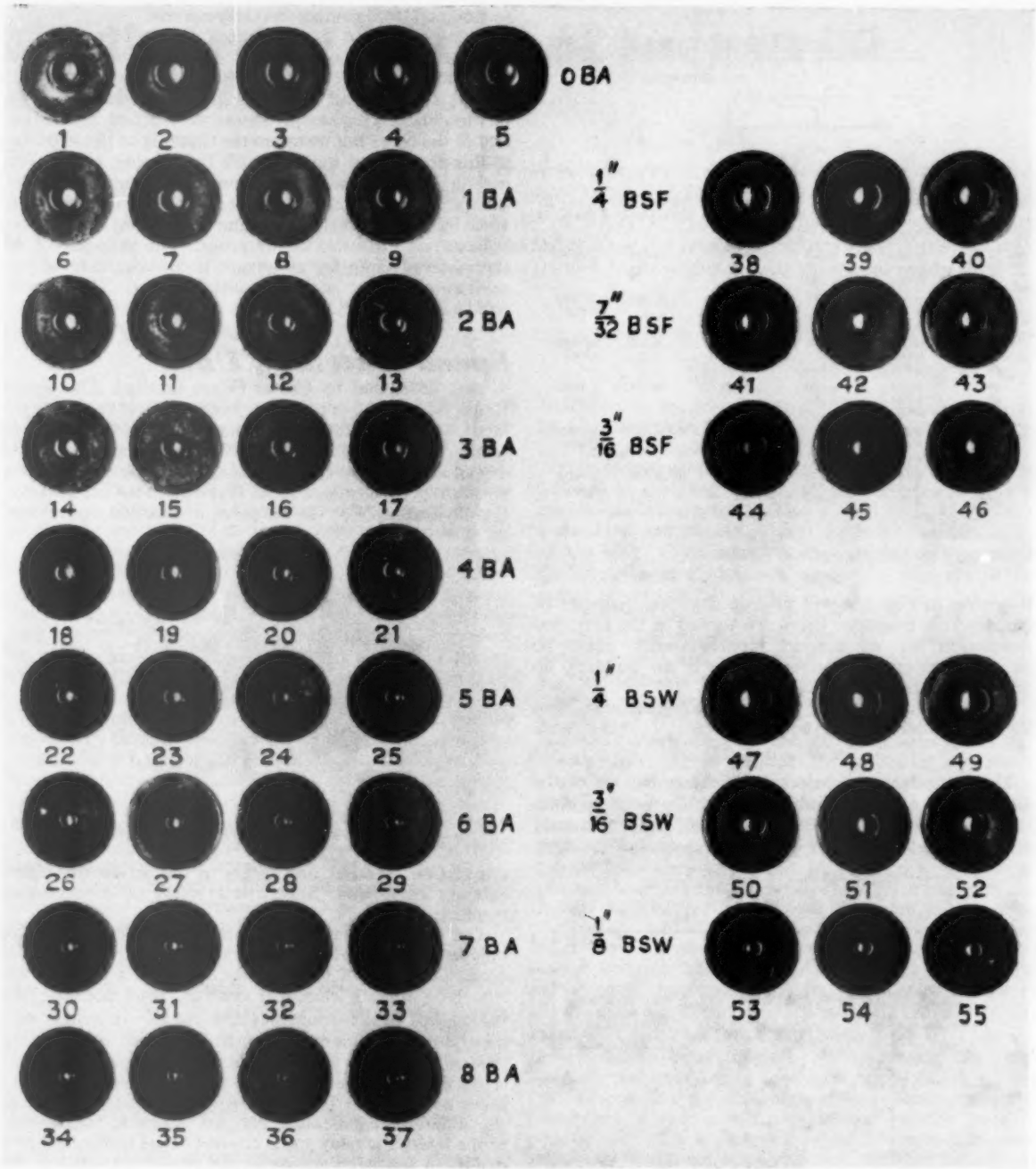


Table II

Component No.	Initial Hole d_1 Dia	Total Height h	Punch and Tapping d	Die and Max Neck Dia D	No. BA
18	0·062	0·034	0·121	0·183	
19	0·046	0·092	,,	,,	4
20	0·038	0·097	,,	,,	
21	0·025	0·109	,,	,,	
22	0·055	0·077	0·109	0·171	
23	0·043	0·085	,,	,,	5
24	0·032	0·094	,,	,,	
25	0·020	0·104	,,	,,	
26	0·046	0·076	0·097	0·158	
27	0·038	0·085	,,	,,	6
28	0·028	0·091	,,	,,	
29	0·020	0·095	,,	,,	
30	0·043	0·071	0·087	0·149	
31	0·032	0·080	,,	,,	7
32	0·025	0·083	,,	,,	
33	0·020	0·086	,,	,,	
34	0·038	0·060	0·074	0·136	
35	0·028	0·070	,,	,,	
36	0·020	0·074	,,	,,	8
37	0·016	0·080	,,	,,	



Samples of extruded necks made to dimensions given in Tables I, II, III (27/32 real size)

once that the first three components in any group fulfil all requirements in these respects.

Our first consideration is to obtain the diameter of the plunging punch giving the requisite tapping size. This should be chosen to ensure tap clearance to facilitate the tapping process. The tapping size exceeds the root diameter of the screw thread, the depth of which will be a predetermined percentage of the full thread.

A partial section of an extruded component and screw, in this instance having a BA screw thread, is shown in Fig. 2.

Let, x = Percentage of full thread required
d_o = Full diameter of screw
d_t = Full depth of screw thread
d = Tapping size diameter = diameter of plunging punch

Then tapping size diameter $d = d_o - x.2d_t$ . . . .(1)

In all examples considered in this article, tapping sizes are such that 63% of a full thread is obtained.

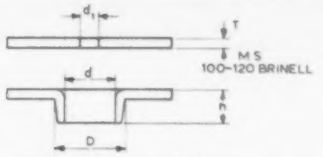


Table III

Component No.	Initial Hole d_1 Dia	Total Height h	Punch and Tapping d	Die and Max Neck Dia D	Screw & Thickness T
					in
38	0·109	0·148	0·219	0·341	¼ BSF
39	0·081	0·167	,,	,,	0·061
40	0·063	0·180	,,	,,	
41	0·094	0·141	0·185	0·307	$\frac{5}{16}$ BSF
42	0·073	0·152	,,	,,	0·061
43	0·055	0·164	,,	,,	
44	0·081	0·110	0·158	0·250	$\frac{3}{8}$ BSF
45	0·063	0·121	,,	,,	0·046
46	0·046	0·132	,,	,,	
47	0·104	0·139	0·209	0·331	¼ Whit
48	0·081	0·154	,,	,,	0·061
49	0·063	0·167			
50	0·073	0·113	0·153	0·245	$\frac{5}{16}$ Whit
51	0·063	0·121	,,	,,	0·046
52	0·046	0·031			
53	0·052	0·073	0·104	0·166	¼ Whit
54	0·042	0·080	,,	,,	0·031
55	0·032	0·091	,,	,,	

Thus, tapping size diameter $d = d_o - 0{\cdot}63 \,.\, 2 \,.\, d_t$

or $d = d_o - 1{\cdot}26\, d_t \quad . \quad . \quad . \quad .(2)$

Referring to Fig. 2 it will be seen that this diameter of tapping hole truncates the screw thread in the extruded component by an amount approximately equal to the rounded crest—assuming there is no building up of the thread by the tapping process.

The diameter of the die bore is equal to the maximum outside diameter of the extruded neck.

or $D = d + 2T$

The second consideration is the determination of the diameter d_t of the initial hole. In all groups—Tables I to III, diameter d_t = 50%, 40% and 30% approximately of the diameter d of the plunging punch for the first, second and third components respectively.

For Component 1 and No. 0 BA, the initial hole diameter is given as 0·098 in. which is about 48% of the plunging punch diameter. Actually Component No. 5 in this group had an initial hole diameter 19% that of the punch. This sample shows no fracture at the free end of the neck, but owing to the thinning of the material at this point is not quite suitable for tapping, and in any case the neck is unnecessarily long. The sample would be satisfactory for other purposes—where a maximum value of the total height h of the component is desirable—hence its inclusion in the group. The thickness T of the material given for all groups is considered to be the minimum for the screw threads involved. This aspect will be investigated. *To be continued.*

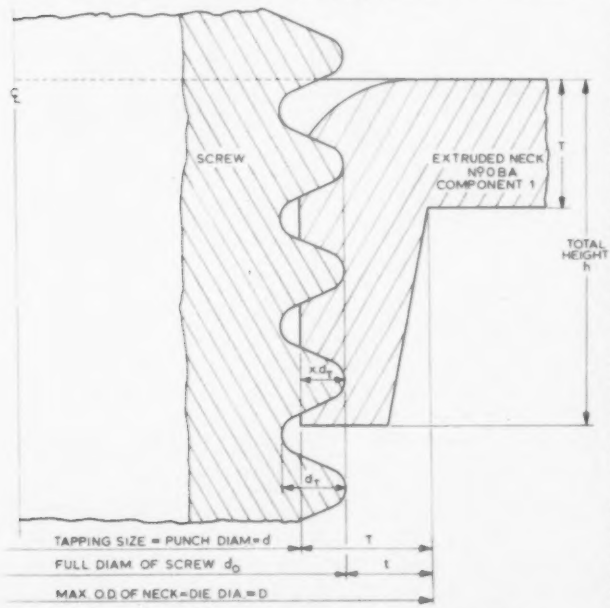
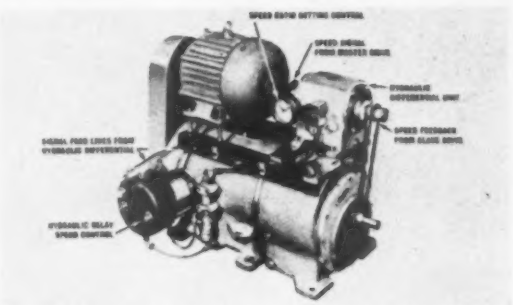


Fig. 2.—Enlarged partial section of extruded neck component and screw

Speed Matching Unit

A unit developed by Carter Gears Limited, Thornbury Road, Bradford 3, Yorkshire, to demonstrate an arrangement which enables two or more independent variable speed sections of a multi-drive-point machine to be driven at the same speed or at speeds which maintain a constant predetermined ratio, is shown in the accompanying illustration. For the purposes of this description and



Speed matching unit with Carter variable speed drives

illustration 'Master' unit refers to the driven machine's primary drive and 'Slave' unit refers to a secondary machine drive.

The Carter variable speed drives to each section are independently motor driven and the Master variable speed unit control is manually operated, e.g. by hand-wheel or remote electrical control, thus deciding the basic speed of the whole machine. An oil differential unit incorporating a manually controlled speed ratio setting device is driven at opposite ends from convenient shafts of the Master and Slave machine sections. Should there be any drift from the required speed relationship the differential generates a signal which is transmitted to the hydraulic relay speed control of the Slave drive and results in the re-balancing of the speed relationship. By suitably adjusting the differential unit, the Slave section may be adjusted to run at any speed from Master section speed downwards and the two sections will always maintain the pre-arranged speed ratio, irrespective of the speed of the manually controlled Master section.

This basic control arrangement has been successfully applied by Carter Gears Limited to several types of multi-drive-point machines requiring speed matching or ratio setting features for two or more variable speed sections. A separate differential unit is of course required for each Slave section, to compare its speed with that of the previous adjacent machine section.

Radioactive Dating of Industrial Products

Many products are required to carry a record of their date of manufacture. The possibility now exists of putting the data in the material in the form of a pair of radioactive elements, The method has obvious value where the material cannot be marked, where inscriptions would be eroded, or where parts are too small for mechanical marking

By P. G. MORGAN

THE use of radionuclides for the dating of geological formations and archeological objects is fairly well known and is developing into an extremely useful research tool. The methods used are suited to time scales of the order of thousands of years, but recent work has suggested that similar techniques might be applied to shorter-term dating of industrial products.[1]

Many manufactured components need to be marked with their date of manufacture, or with some identification mark, since in many circumstances, an accurate knowledge of the age of a given product is necessary. For example, in the corrosion or weathering resistance of specimens, or the deterioration of a product during storage, conventional dating methods are inadequate and, in many cases, impracticable. Surface markings are easily obliterated by fouling, corrosion, abrasion or other methods of deterioration; when marked objects have been painted or buried, for example, they have to be brought back to their original state before any surface indication of the date of manufacture can be read. In addition, the mass production of small size objects in certain industries makes dating by serial number extremely cumbersome.

The above industrial dating requirements concern definite items of equipment, but there are a number of potential uses of radioactive dating in a wide range of industries. For example, the technique offers a method of dating each particle within a container instead of merely dating the outside of the container itself. One may thus be able to obtain a reliable age for liquids or powders regardless of the number of times that the bulk supply is separated or transferred from one storage vessel to another. Further, the dating method provides a means of measuring the average age of material within a vessel to which periodic withdrawals and additions are made.

The petroleum refining industry has been suggested as a suitable field in which the above processes might be applied, particularly in operations connected with tank farm storage and catalytic cracking. Cracking activity, surface area and pore volume of fluidized cracking catalysts de-activate and diminish with use, and it is not uncommon for large cracking units to lose catalyst fines in waste gases at a rate of 5–10 tons per day. Consequently, to maintain an approximately constant level of catalyst activity, fresh catalyst is continuously added and spent catalyst is periodically withdrawn. By using the radioactive techniques, the rates at which fresh catalyst is introduced and used catalyst is discharged may be proportioned to keep the total catalyst at a pre-determined average age, and thus maintain the activity at the desired level.

The technique used consists of introducing into the product at the time of manufacture a selected pair of radioactive elements, one with a long half-life to act as a standard and the other, with a shorter half-life, to act as the timer. The ratio of the amounts of the radioactive elements at different times is a measure of the age of the product.

The experimental work carried out so far has been applied to the measurement of the age of petrol and of rubber, with β and γ radiation from the timer element and transmission techniques to measure the amount of radioactivity. The pairs of elements used so far include Cl^{36}/Mn^{54}, Cl^{36}/Nb^{95}, Tc^{99}/Nb^{95}, but there are a number of factors which influence the ultimate choice of the pair of elements. These include the counting equipment available, the availability of the chemical isotopes, the compatibility of the chemical forms with the product to be dated and the time period itself. The number of pairs of isotopes from which a choice can be made is theoretically very large, but in practice is greatly restricted, since the radiation from any given pair may not have a sufficiently wide spread of energy to determine their ratio, and the useful age span is limited to less than the time needed for radioactive equilibrium to occur between the two elements. Pairs of elements which meet the above specifications may then have to be rejected on chemical considerations relating to the product with which they are to be used.

Sources of error inherent in this dating technique include the uncertainty in the accepted value of the half-life, statistical fluctuations in the counting rate and the effect of radioactive contaminants within the substance itself. These factors may be minimized to some extent by the choice of pair species, but they have so far limited the accuracy to an average overall figure of $\pm 5\%$.

The above list of practical difficulties and sources of error appears at first sight to limit the possibilities of accurate measurment, but the adoption of such methods for industrial dating would accelerate the development of new techniques, particularly those associated with lower levels of radiation and the use of β and γ scintillation spectrometry measurement, and it may well be that radioactive dating will soon be accepted as a standard method of process control.

Reference
1 Gregson, T. C. Waisbrot, S. W., Gehman, S. D. *Nucleonics*, **19**, 6, p. 90 (1961)

Pneumatic Control Valves

Two new items of pneumatic control equipment have been introduced by Westinghouse Brake and Signal Company Limited, Hanham Road, Kingswood, Bristol. They are a quick release valve and a compact cam-operated on/off valve.

The quick release valve is shown in section in Fig 1. Its purpose is to reduce the time required to release brakes by fastening the exhaust of air pressure from the brake chambers. Essentially, a spring-loaded diaphragm is so arranged as to permit air pressure to

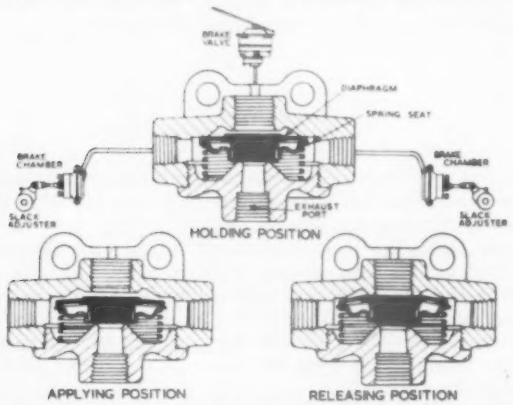


Fig 1.—Quick release valve for air brakes showing disposition of moving parts for applying, holding and releasing brakes

flow in one direction (to brake chambers; see "applying position" in sketch), to maintain the pressure ("holding position") when the rim of the diaphragm is raised, and to release the pressure ("releasing position") when the whole diaphragm is lifted.

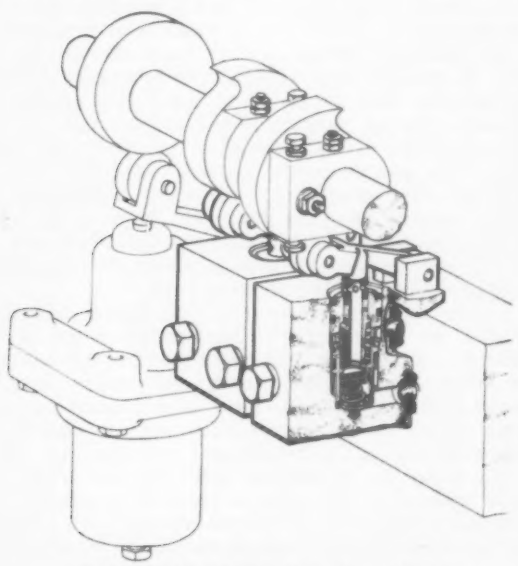


Fig 2.—Pilotair on-off valve with interchangeable unit

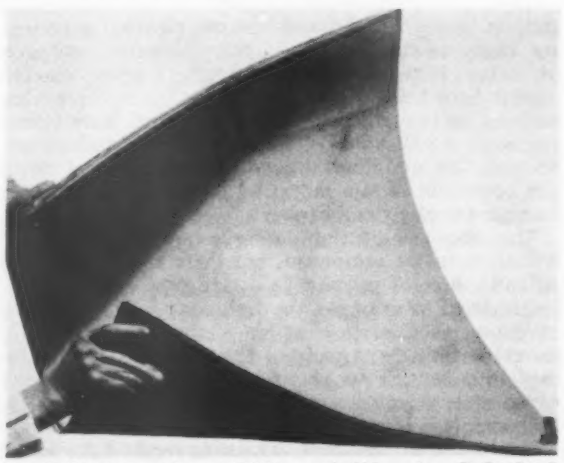
The on/off valve is shown in Fig 2. Named the "Pilotair", it consists essentially of a hollow plunger which is operated by a lever against a return spring and through which the line is exhausted when the air is turned off, and a plate valve held on its seating by a conical spring. These parts can be seen in the sectioned part of Fig 2.

In operation, a downward movement of the plunger first seals off the exhaust when the mouth of the plunger seats on the top of the plate valve; further movement unseats the valve against the conical spring. When the lever operating the plunger is released, the plunger return spring lifts the plunger thus allowing the plate valve to be reseated. closing off the supply air and allowing the line to exhaust to atmosphere.

A typical application of the Pilotair valve is its use in a cam box where several valves can be mounted on a common pipe bracket. All valves contain an interchangeable on/off unit retained in the body by a circlip. Bodies may be die cast or machined and for pipe-bracket or through-bolt mounting.

Air Fluidizing Panels

The new fluidizing technique developed by Mono Pumps Limited, Sekforde Street, London, EC1, for powder discharge from bins and hoppers obtains a controllable response of powder to the pull of gravity without resorting to force to achieve powder distribution and without the excessive use of air. Two types fluidizing panels are custom-made for this purpose, one being rigid for application to plane surfaces of containers and the other of a flexible nature for use on containers having contoured surfaces. Each panel consists of an air chamber with an upper working surface of special smooth air-permeable material which possesses minute pores for distributing the air feed.



Mono flexible Hovermat is an air fluidizing panel which can be easily flexed to fit conical hoppers, for solving the problem of powder discharge from hoppers

Standard Clean Rooms

A range of pre-fabricated "standard clean rooms" has been designed by John Bass Limited, Crawley, complete with plant unit to provide full temperature and humidity control, giving filtration down to one micron. Each room is provided with comprehensive erection instructions, which enable the customer to build his own room, and the equipment is semi-portable and therefore the site can be moved at very slight cost. The installation can also be used as a standards room in which to house delicate measuring instruments which are sensitive to atmospheric change; the humidity or temperature level can be varied to suit requirements.

Make It or Buy It?

Quite often the cost of development work in finding a solution to a detail design problem can be eliminated because a suitable "ready-made" component already exists. The problem is then one of "search" rather than "research". This article discusses the importance of product research and suggests the need for a "memory" section between the design office and the buyer

OF the tens of millions of pounds spent on development work a considerable proportion must be spent in duplication of effort. There is no means of checking, or even hazarding a reasonably accurate guess at what the figure is, but it is there and represents additional cost and waste. Also it is not a problem which lends itself to simple solution as a whole.

The culprit, more often than not, is a single component performing a vital function in a particular assembly. A problem has arisen at the design stage which needs an original solution (at least as far as that design office is concerned). It is not a standard component readily available from the usual suppliers so the decision is taken to make it as a 'special'—more design work, development and 'proving' and eventual tooling for production. Months later when the assembly is finally ready to go out, a visiting engineer comments on the original solution of the detail design problem and adds words to the effect that 'so-and-so are producing the same idea in a much simpler fashion: did you find it would not do this job'. The only reason it 'would not do the job' was simply that nobody in the works had any idea it existed!

This is not a hypothetical case. It happens every week. So many firms all over the world are producing new and clever ideas that it is virtually impossible to keep track of them. These firms, too, are often small, or the design unit is a small part of their normal production, so the thought of getting the item publicised in the proper manner is either considered uneconomic or just plain unnecessary. Equally it may never even occur to the originators that the device *has* scope outside a particular application they produced it for. Even if it has received brief mention in a news paragraph in a trade paper the odds are that it will not be seen and filed in an intelligent manner where it can be traced at some future date. More often than not, too, the fact that some really good ideas do get mentioned in the trade papers is due to the enthusiasm and enterprise of the editors in chasing up a particular lead. Public relations and the employment of a sound P.R.O. are the last item on the agenda (if it ever gets there at all) when the operating budget for most firms is considered.

Even publicity given to each and every possible product of practical value is not much good on its own. Each technical journal contains, in various ways, any number of significant reports, contact addresses, details of new products, etc. Those which correspond to an immediate requirement will probably receive action, provided the man with the problem has time to work through that particular journal. The majority of references will not correlate to any immediate problem and in time will be only vaguely remembered or forgotten, even if they are consciously absorbed at the time of seeing the journal. Theoretically the source is still there with the filing of the various issues of each journal—but the physical job of *finding* the particular reference on a vague memory some months later can be completely frustrating.

Where a business can gain in 'buying it' rather than 'making it' as far as small components, etc., are concerned, there is a distinct case for a staff position intermediate between the design office and the buyer where the sole responsibility is simply to collect, collate, file and cross reference every trade news item which could be of possible interest and use. Also this is a job for an engineer rather than a filing clerk so that references can be evaluated on merit and, where necessary, followed through to elaborate the file contents. At the same time this department can feed the design office with possible useful information on new materials, etc (which is where an engineering background is necessary to command sufficient respect from the design staff *and* ensure that the design staff's time is not wasted by circulation of useless information). Liason with the buying department would also serve to act as a double-check on availability, particularly on items which may run into short supply and where the buyer would otherwise have to start searching for alternatives.

In one typical case history, firm A had a call for a panel knob control which had to maintain a perfect diaphragm seal. Nobody from design office down to buyer had any knowledge of a suitable component being available so some four months were spent in developing this particular component for the job. Even then it was not an entirely satisfactory solution, as well as being costly to make, and things had got to the stage of considering a major re-design of the whole unit. Before a final decision was taken, a clue came from a new draughtsman who had just been taken on. He remembered seeing some details of a similar control transmission in an American journal.

Enquiries via the journal's editorial offices brought the 'contact' address—back in England less than twenty miles away. They had the complete solution in a simple design which had been produced initially for a quite different job and were actually making limited numbers as a standard item for the few people who had shown interest. The particular journal in which the information originally appeared—and at least two British journals which had also mentioned the same thing—all circulated throughout firm A. Nobody remembered the item simply because at the time of reading or skipping through the journals it had no interest or association with current work.

Another case history concerns firm B who a year or two ago delegated one of their design staff as a 'memory man' for collecting and collating all published data which could conceivably interest the firm's field of manufacture. Additional overheads were cut down to an office and secretarial assistance (also doubling for filing work) but the cost, it is now reckoned, is saved ten

times over on production each year. It is possible to approach the department with virtually any request of the kind "Does anybody make . . . ?" and get more or less a complete answer in a majority of cases—i.e. not just a journal cutting with an address but further material appended which has been collected by following up a promising reference. On file, in addition, are current catalogues of normal suppliers, competitors and other manufacturers of 'fringe' interest—with a *working knowledge* of their contents. In other words, to be fully effective the person in charge of such a department must be familiar with the engineering background concerned with it, not just a glorified filing clerk doing a routine job.

Obviously the value of such a department is strictly related to the type of firm and its products. If it handles a limited, fairly standardized type of production all necessary material and component supplies can be met by a limited number of regular suppliers, with the design or development engineers absorbing what new information might be significant. Where new designs are continually being developed, however, everything that is new in that particular field could be of significance. Half a dozen people in the design office arguing about and enquiring for a particular size of dashpot, clutch drive, etc., can waste an awful lot of manhours. With a properly organized 'memory' department a phone call could bring up brochures covering the component in dispute in a matter of minutes.

Electronic Instruments

The range of ElectroniK instruments constructed on the "modular" principle, which may be incorporated in existing ElectroniK instruments, consists of constant voltage unit, measuring circuit unit, a sectionalized balancing motor and quick release amplifier.

The constant voltage unit, which obviates batteries and periodic standardizing, keeps the voltage across the slidewire to $\pm$ 0·03% for $\pm$ 10% line variations, or $\pm$ 0·15% where ambient temperature varies $\pm$ 55%. This is achieved by regulating the output voltage of a small a.c.-d.c. supply with cascaded Zener diodes; a high output stability is achieved without change in the instrument's accuracy. Spurious pen movement is thus eliminated and the unit requires no maintenance.

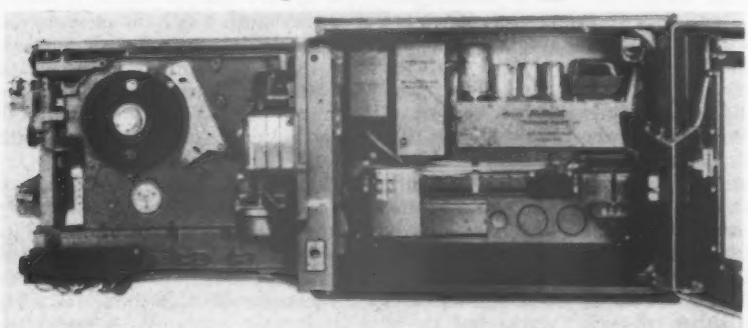
The measuring circuit unit is fully self-contained and has clip-on resistor panels for quick range changing; no soldering is involved, the change requires no specialist skill and so can be made by means of a screwdriver. Similarly, changing the actuation requires only the alteration of a spool panel and the fixing of a new chart or scale. Improved defence against stray voltages is achieved by shielding and the use of short cable runs.

The sectionalized balancing motor comprises four easily accessible sections and any major part is replaceable within two minutes. It incorporates built-in shock absorbers and has leak proof oil-wick lubrication.

New electronic strip recorder-controller incorporating Honeywell 'modular' construction

Any of fifteen amplifier units with quick connect plug may be fitted providing gain of up to 40 million times for input impedances between 400 and 50,000 ohms.

Makers of these instruments are Honeywell Controls Limited, Ruislip Road East, Greenford, Middlesex.

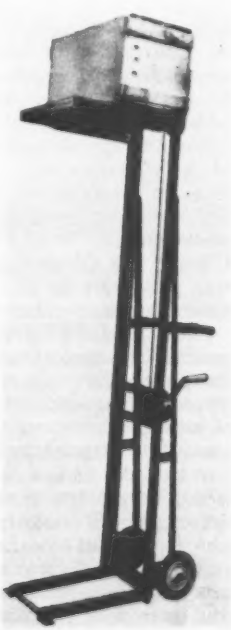


Rear view of 'modular' electronic strip chart recorder-controller showing, left to right, constant voltage unit measuring circuit unit, and plug-in amplifier; the sectionalized motor is just to the left inside the swing door

Hand Elevator Truck

The "Quik Lift" hand operated elevator truck is made to lift or lower light loads rapidly, the maximum load being 350 lb. It has a winch of novel construction.

A safety feature is that the elevator is self-sustaining at all heights, yet neither brake, nor ratchet and pawl mechanism is necessary. The load automatically remains stationary whenever the operator releases the handle. The wire rope pulleys run on needle bearings and the carriage rollers have roller bearings. Standard platform size is 21 in. long $\times$ 22 in. wide. The model illustrated lifts to 7 ft and is fitted with two 8 in. dia wheels so that it can be easily manoeuvred into the working position. Another version, suitable where floor surfaces are even, has two 4 in. front wheels and two rear wheels in swivel castors. These elevators can be made to lift to any height between 4 ft and 10 ft.—Powell & Company, Burry Port, Carms.



The "Quik Lift" hand operated truck has an elevation of 7 ft

Preliminary Design of Gas Turbine Plant—IV

Selecting the main dimensions of the compressor

By W. R. THOMSON, B.Sc.Tech.

7. The compressor

7.1. General

This treatment is approximate in the sense that it provides only the main dimensions of the machine, i.e. inside and outside diameters at entry and exit, number of stages, and overall length, all of course of the bladed portion. The design is limited to the first and last stages, the machine length being obtained by assuming as a mean stage length the average length of these two stages. Fig. 7 shows this bladed portion in outline.

7.2. Velocity triangles

Fig. 8 shows the velocity triangles for a stage (the first) in relation to the blades of the rotor and stator (after the inlet guide vanes). Fig. 9 shows the two velocity triangles in relation to each other. It is to be noted that this pair of triangles is often shown in one diagram with a common apex.

When the reaction is 50%, the two triangles are similar but opposite handed. Reaction is defined as the ratio of the static temperature rise in the rotor to the total head temperature rise in the whole stage and in terms of velocities and air angles becomes

$$\frac{\text{Tan } \alpha_1 + \text{Tan } \alpha_2}{2u/V_a}$$

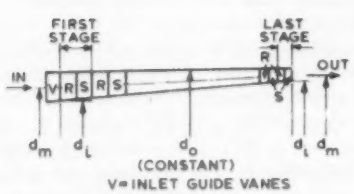


Fig. 7

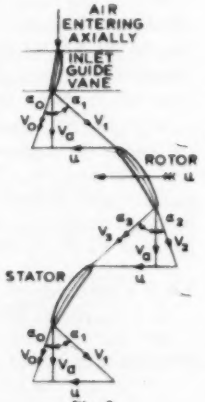


Fig. 8

Figs. 7-10.—Velocity and blade angles for compressor

7.3. Blading

Fig. 10 shows the relationship between the air angles and the blade angles. The names of these angles are given in section 2.2.

Out of the many types of compressor blading available that chosen for this treatment has a circular arc camber line (the alternative is parabolic) with a profile formed on it to standard specification Aerofoil C5. This is a symmetrical aerofoil (i.e. symmetrical about its basic straight camber line) with maximum thickness at 30% of the chord length from the leading edge. Basically this C5 aerofoil has a maximum thickness of 10% of the chord length but in compressor work it varies from 7% at the blade tip, to 10% at mean radius, and up to 13% at the blade root. The leading and trailing edge radii are both 12% of the maximum thickness.

7.4. Design assumptions

(a) Blade design by the constant α_2 method.
(b) M on rotor blade not to exceed 0·6.
(c) Constant d_o.
(d) d_i/d_o not less than 0·7 at entry to first stage.
(e) u_m not greater than 750 fps at exit from last stage.
(f) 50% reaction at d_m.
(g) Pitch/chord ratio (s/c) to be 0·7 at d_i.
(h) Thickness/chord ratio (t/c) to be 0·1 at d_m and 0·13 at d_i.
(i) M at exit from last stage to be 0·3.
(j) Nominal conditions at or very close to maximum lift/drag ratio.
(k) Axial velocity of the air, V_a, is assumed to be constant over any annular area.

7.5. Application of condition (j)

For a particular blade the plot of deflection (ϵ) versus incidence (i) gives a smooth curve up to stall where the deflection is well defined but the incidence

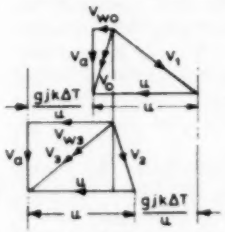


Fig. 9

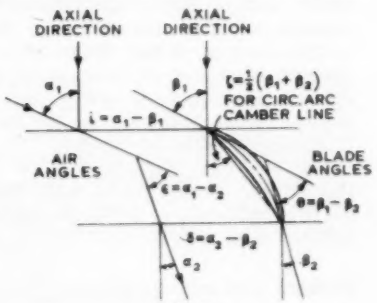


Fig. 10

not so. Nominal conditions are therefore defined as those where the deflection (ϵ^*) is 0·8 of the maximum (at stall), the corresponding incidence being i^* and being clearly defined on the curve. These conditions are used in this design. This will correspond very closely to maximum lift/drag ratio to obtain which a blade will require a particular value of "air angle in" (α_1) to suit the u/V_a and s/c for the case. Fig. 11 shows a plot of tan α_1 against u/V_a for various values of s/c covering the point of maximum lift/drag ratio in every case.

Whilst any one point of the blade (usually called the "design point", usually at mean diameter) may be made to work according to Fig. 11 at the correct relationship between tan α_1, s/c, and u/V_a, this cannot

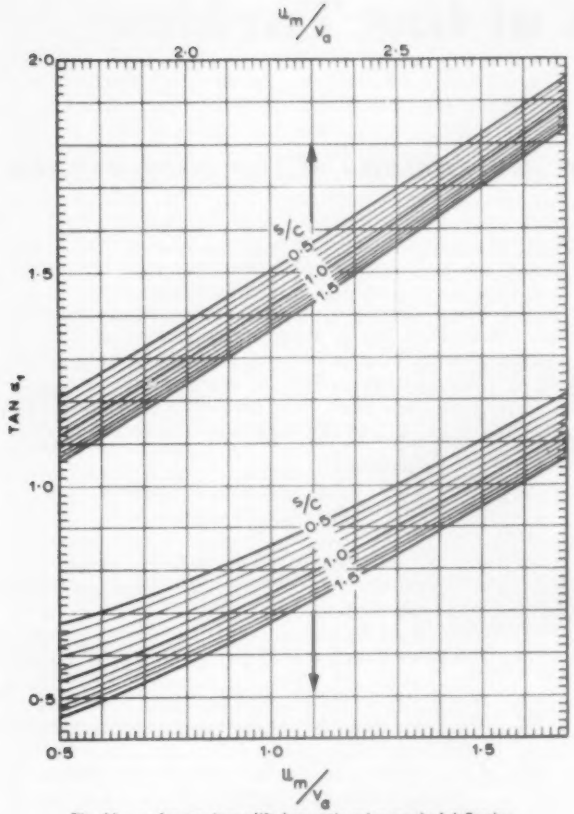


Fig. 11.—α_1 for maximum lift drag ratio using nominal deflection

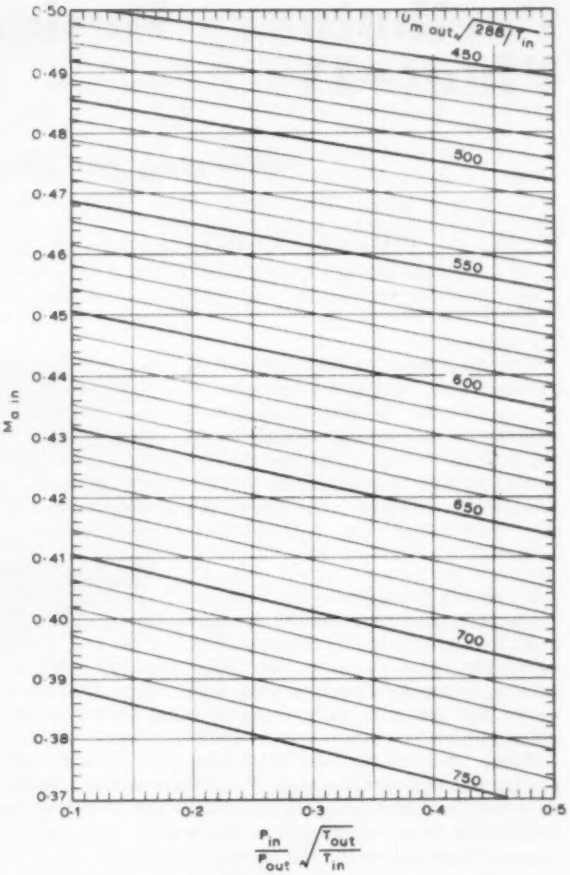


Fig. 12.—Graph of Mach number at entry to compressor

be true at any other point on the blade since s/c for the blade follows a geometric law and tan α_1 will vary along the blade according to the type of design specified under sect. 7.4(a). Alternatives to the constant α_2 method specified are constant reaction, free vortex, and half-vortex. Whilst the curves of Fig. 11 are for the absolute maximum lift/drag ratios, considerable variation can be permitted on either side of each maximum without great reduction in the ratio, the curves concerned being fairly flat-topped.

For the first stage it will be convenient to make the *tip* the design point since the condition of sect. 7.4.(b) applies there. With constant α_2 blading and with a hub/tip ratio (d_i/d_o) of 0·7 it is found that the reaction (defined most conveniently as $\dfrac{\tan\alpha_1 + \tan\alpha_2}{2\,u/V_a}$) at the tip is about 55% when that at mean diameter is 50%. If therefore a reaction of 55% is fixed at the tip, that at mean diameter will be *about* 50% and in view of the resulting simplification of design it is not considered a disadvantage that the reaction at mean diameter is not *precisely* 50%.

For the last stage the design point will be at mean diameter with a reaction of exactly 50%.

7.6. Mach number at entry

To provide a quick method for selecting a value of M_a at inlet to the first stage in satisfaction of all the conditions of 7.4, a rather complex equation is built up and plotted in Fig. 12. The alternative is a slow process of trial and error.

7.6.1. Basic

If V is the total velocity of a fluid having component velocities V_1 and V_2 mutually normal, $V^2 = V_1^2 + V_2^2$. The Mach No. corresponding to V is $M = V/\sqrt{g\gamma RT_s}$, where T_s is the static temperature of the flowing fluid. The Mach Nos. of the component velocities are $M_1 = V_1/\sqrt{g\gamma RT_s}$ and $M_2 = V_2/\sqrt{g\gamma RT_s}$ where T_s is the same throughout, and is $T/[1 + \frac{1}{2}(\gamma-1)M^2]$. Thus $M_2 = M_1^2 + M_2^2$. Referring to Fig. 8 where the inlet guide vane deflects the total velocity of the air V_o through angle α_o, the axial velocity into the first stage rotor is $V_a = V_o \cos\alpha_o$ and its $M_a = M_o \cos\alpha_o$.

7.6.2. Continuity of flow

$Q = \rho_o A_o V_o$ into first stage $= \rho A V_a$ out of last stage.

In: $A_o = A \cos\alpha_o$ and $V_o = V_a/\cos\alpha_o$ where A = annulus area hence $A_o V_o = A V_a$.

$$\rho_o = 1{\cdot}5\frac{P_s}{T_s} = 1{\cdot}5\frac{P}{T}\cdot\frac{1}{[1+\frac{1}{2}(\gamma-1)M_o^2]^{1/(\gamma-1)}}$$

$$= 1{\cdot}5\frac{P}{T}\cdot\frac{1}{[1+\frac{1}{2}(\gamma-1)(M_a^2/\cos^2\alpha_o)]^{1/(\gamma-1)}}$$

$$V_a = \sqrt{\frac{g\gamma RM_a^2T}{1+\frac{1}{2}(\gamma-1)(M_a^2/\cos^2\alpha_o)}}$$

$$\therefore Q = A\,1{\cdot}5\frac{PM_a}{\sqrt{T}}\cdot\frac{\sqrt{g\gamma R}}{[1+\frac{1}{2}(\gamma-1)(M_a^2/\cos^2\alpha_o)]^{(\gamma+1)/2(\gamma-1)}}$$

Out: Total velocity in axial

$$Q = A\ 1{\cdot}5\,\frac{PM_a}{\sqrt{T}}\cdot\frac{\sqrt{g\gamma R}}{(1+\frac{1}{2}(\gamma-1)M_a^2)^{(\gamma+1)/2(\gamma-1)}}$$

Equating these and qualifying the *A*'s, *P*'s, and *T*'s,

$$\frac{P_{in}}{P_{out}}\sqrt{\frac{T_{out}}{T_{in}}} = \frac{A_{out}\,M_{a\ out}}{A_{in}\,M_{a\ in}}\left\{\frac{1+\frac{1}{2}(\gamma-1)(M_a^2{}_{in}/\cos^2\alpha_o)}{1+\frac{1}{2}(\gamma-1)M_a^2{}_{out}}\right\}^{(\gamma+1)/2(\gamma-1)}$$

Now use $\gamma = 1{\cdot}4$, $(k = 0{\cdot}24)$, $\frac{1}{2}(\gamma-1) = 0{\cdot}2$, $(\gamma+1)/2(\gamma-1) = 3$, $M_{a\ out} = 0{\cdot}3$, $1+\frac{1}{2}(\gamma-1)\ M_a^2{}_{out} = 1{\cdot}018$. Also since this analysis is concerned with the rotor tip (see 7.6.4) a value can be assigned to α_o, say 45°, to exceed anything met in practice for safety; then $\cos^2\alpha_o = \frac{1}{2}$ and the equation becomes

$$\frac{P_{in}}{P_{out}}\sqrt{\frac{T_{out}}{T_{in}}} = \frac{A_{out}}{A_{in}}\,\frac{(1+0{\cdot}4\ M_a^2)^3}{3{\cdot}51}$$

7.6.3. Geometry

$$\frac{A_{out}}{A_{in}} = \frac{(d_o^2-d_i^2)_{out}}{(d_o^2-d_i^2)_{in}}$$

But d_o is constant and $(d_i/d_o)_{in} = 0{\cdot}7$

$$\therefore\ \frac{A_{out}}{A_{in}} = \frac{1-(d_i/d_o)^2{}_{out}}{0{\cdot}51}$$

$$\text{Also}\ \frac{u_{m\ out}}{u_{m\ in}} = \frac{d_{m\ out}}{d_{m\ in}} = \frac{1+(d_i/d_o)_{out}}{1{\cdot}7}$$

$$\text{whence}\ (d_i/d_o)_{out} = \frac{1{\cdot}7\ u_{m\ out}}{u_{m\ in}} - 1$$

7.6.4. At rotor tip

$M_1 = {\cdot}6$ (see Fig. 8).

$$\therefore\ \tan\alpha_1 = \sqrt{\frac{V_1^2}{V_a^2}-1} = \sqrt{\frac{M_1^2}{M_a^2}-1} = \sqrt{\frac{0{\cdot}36}{M_a^2}-1}$$

Further, as $s/c = 0{\cdot}7$ at d_i and $d_i/d_o = 0{\cdot}7$, $s/c = 1$ at d_o i.e. at the tip. Using Fig. 11 and limiting the broad range of u/V_a to the more limited one in this design of from 1 to 2 the curve for $s/c = 1$ may be approximated to a straight line with the equation.

$$\tan\alpha_1 = 0{\cdot}191 + 0{\cdot}546\ u/V_a$$

Equating these

$$0{\cdot}546\ u_o/V_a = \sqrt{0{\cdot}36/M_a^2-1} - 0{\cdot}191$$

$$\text{But}\ V_a = \sqrt{\frac{g\gamma RM_a^2T}{1+\frac{1}{2}(\gamma-1)(M_a^2/\cos^2\alpha_o)}}\ \text{and}\ u_m = 0{\cdot}85\ u_o$$

$$\text{whence}\ u_o = \frac{1}{0{\cdot}546}\sqrt{\frac{g\gamma RM_a^2T}{1+\frac{1}{2}(\gamma-1)(M_a^2/\cos^2\alpha_o)}}\left(\sqrt{\frac{0{\cdot}36}{M_a^2}-1}-0{\cdot}191\right)$$

and substituting for g, γ, and R (= 96), and leaving room to vary the inlet temperature to the compressor

$$u_{m\ in} = \frac{0{\cdot}85}{0{\cdot}546}\sqrt{\frac{T}{288}}\sqrt{\frac{32{\cdot}2\times1{\cdot}4\times96\times288M_a^2}{1+0{\cdot}4\ M_a^2}}\left(\sqrt{\frac{0{\cdot}36}{M_a^2}-1}-0{\cdot}191\right)$$

$$= 1737\sqrt{\frac{T_{in}}{288}}\,\frac{M_{a\ in}}{\sqrt{1+0{\cdot}4\ M_a^2{}_{in}}}\left(\sqrt{\frac{0{\cdot}36}{M_a^2{}_{in}}-1}-0{\cdot}191\right)$$

7.6.5. Combining these

$$\frac{P_{in}}{P_{out}}\sqrt{\frac{T_{out}}{T_{in}}} = \frac{1}{0{\cdot}51}\left\{1-\left(\frac{d_i}{d_o}\right)^2_{out}\right\} = \frac{1}{0{\cdot}51}\left\{1-\left(\frac{1{\cdot}7\ u_{m\ out}}{u_{m\ in}}-1\right)^2\right\} = \frac{1}{0{\cdot}51}$$

$$\left[1-\left\{\frac{1{\cdot}7\,u_{m\ out}\sqrt{1+0{\cdot}4\ M_a^2{}_{in}}}{1737\,M_{a\ in}(\sqrt{0{\cdot}36/M_a^2{}_{in}-1}-0{\cdot}191)}-1\right\}^2\right]$$

$$\text{and}\ \frac{P_{in}}{P_{out}}\sqrt{\frac{T_{out}}{T_{in}}} = \frac{(1+0{\cdot}4\ M_a^2{}_{in})^3}{0{\cdot}51\times3{\cdot}51}$$

$$\left[1-\left\{\frac{u_{m\ out}\sqrt{288/T_{in}}\sqrt{1+0{\cdot}4\ M_a^2{}_{in}}}{1020M_{a\ in}(\sqrt{0{\cdot}36/M_a^2{}_{in}-1}-0{\cdot}191)}-1\right\}^2\right] = \frac{(1+0{\cdot}4\ M_a^2{}_{in})^3}{1{\cdot}79}$$

$$\left[1-\left\{\frac{u_{m\ out}\sqrt{288/T_{in}}\sqrt{1+0{\cdot}4M_a^2{}_{in}}}{1020M_{a\ in}(\sqrt{0{\cdot}36/M_a^2{}_{in}-1}-0{\cdot}191)}-1\right\}^2\right]$$

7.6.6. The graph for $M_{a\ in}$

Fig. 12 is prepared from this equation treating the three variables as $\frac{P_{in}}{P_{out}}\sqrt{\frac{T_{out}}{T_{in}}}$, $u_{m\ out}\sqrt{\frac{288}{T_{in}}}$, and $M_{a\ in}$. Thus, knowing $u_{m\ out}$ (either 750 or see 7.8), P_{in}, T_{in}, P_{out} and T_{out} for the whole compressor (from the cycle analysis) the approximate value of M_a into the first stage rotor can be read off. The use of $\sqrt{288/T_{in}}$ permits the use of any inlet air temperature in spite of the previous approximation due to fixing γ at 1·4.

7.7. Fixing the compressor speed

Using $u_{m\ out} = 750\sqrt{288/T_{in}}$ read M_a to first stage from Fig. 12. From Table IV, using γ from the cycle calculations for the whole compressor, and $M_{a\ in}$ read $(Q\sqrt{T}/AP)_{in}$. Calculate A_{in}, the annulus area. Using $(d_i/d_o)_{in} = 0{\cdot}7$, $\frac{1}{4}\pi d_o^2 = A_{in}/0{\cdot}51$, hence $d_{o\ in}$ Using $M_{a\ out} = 0{\cdot}3$, read $(Q\sqrt{T}/AP)_{out}$ from Table IV. Using T_{out} and P_{out}, calculate A_{out}. Calculate $d_{i\ out}$ from $\frac{1}{4}\pi d_i^2 = \frac{1}{4}\pi d_o^2 - A_{out}$, remembering d_o is constant Then $h_{out} = \frac{1}{2}(d_o-d_i)_{out}$ and $d_{m\ out} = d_o - h_{out}$. Using $u_{m\ out} = 750$ calculate $N = (720u_m/\pi d_m)_{out} = (229{\cdot}3u_m/d_m)_{out} = 172000/d_{m\ out}$.

7.8. Limitation of *N* by turbine speed

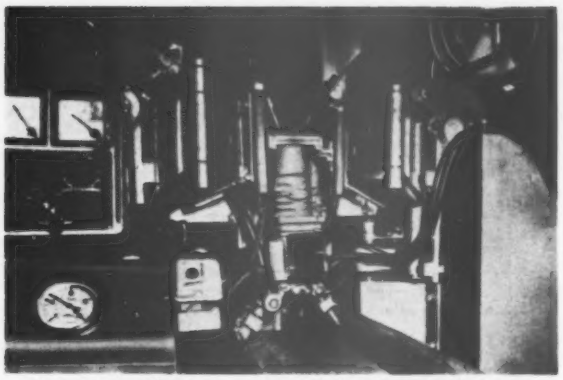
If the compressor must run at less than the N obtained in 7.7, say at N_1, then the $u_m\sqrt{288/T_{in}}$ to be used in Fig. 12 must be reduced by multiplying by N_1/N and a new value of $M_{a\ in}$ obtained. Sect. 7.7. is then worked through again.

7.9. u_m/V_a for first and last stages

Complete the first stage, i.e. $d_i = 0{\cdot}7\ d_o$, $h = \frac{1}{2}(d_o-d_i)$, $d_m = d_o-h$, $u_{m\ in} = u_{m\ out}\ d_{m\ in}/d_{m\ out}$. Then $(V_a/\sqrt{T})_{in}$ from Table IV using $M_{a\ in}$, hence $V_{a\ in}$. Finally $(u_m/V_a)_{in}$.

Similarly complete the last stage, i.e. $(V_a/\sqrt{T})_{out}$ from Table IV using $M_{a\ out} = 0{\cdot}3$. Hence $V_{a\ out}$ and $(u_m/V_a)_{out}$.

To be continued.



I-beam being welded from plate automatically in Pullmax 21-500 machines

Automatic Profile Welder

Automatic production of welded beams, providing low cost sections from steel plate, is a practical achievement of the latest Pullmax machine. In addition it will produce tapered or curved beams, a factor of great value in shipyards, etc.

Beams are fabricated by this new machine from plate pre-cut to the required final thickness and length, the plates then being welded together automatically to form the desired sections. These sections are produced with constant, pre-determined web heights and flange widths. The machine can also be adapted for welding tubes.

The Pullmax 21-500 consists basically of only three main parts: the feeder, two or four fully-submerged automatic welding units, and corresponding welding generators. The feeder is an automatic rail-operated table, mounted on a heavy bottom frame and powered by electric motors, speed variators and hydraulic pressure cylinders. During welding, beams are conveyed under the welding heads by hardened, heat-treated feeding rollers.

One side of the feeder is adjustable to suit the height of the I-beam, the range being from 6 in. to 60 in. Flat iron for flanges can be used with dimensions from 2 in. to 18 in. The feeding speed is infinitely variable from zero up to 5½ ft per min. The constant-voltage, d.c. type, submerged-arc, welding heads are rated at 900 amp. They will handle wire ranging from 0·031 in. to 0·25 in. and are equipped with independent wire-feed controls. Alternatively CO_2 welding equipment can be fitted if desired.

Sole selling agents for Pullmax machines in the U.K. are Alfred Herbert Limited, Factored Division, Red Lane Works, Coventry.

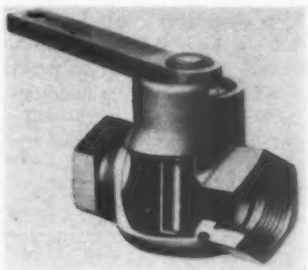
Glass Fibre in Australia

Over the past few years the use of Turners "Duraglas" glass fibre reinforcement materials in Australia has been vast and varied, and today the fabrications range from missile equipment to parts for shops scales. Among products employing Duraglas and made by Chrysler Australia Limited, Finsbury, South Australia, are doors for cement curing ovens, covers for arc welding units, antenna coupling boxes, filter leaves for processing ore, laundry troughs, fuel drop tanks for aircraft, wheel spats for light aircraft, and weighing machine components. Products incorporating Duraglas and manufactured by Freighter Industries (S.A.) Pty. Limited include hinged hoods for rocket tracking camera instrumentation, ski boat hulls, and panels for motor coaches.

Leak Proof Valve

The Claudo leak proof valve for gases and liquids recently introduced by The British Steam Specialties Limited, Leicester, consists of eight simple parts. By the removal of a circlip the whole of the mechanism can be lifted out for replacement while the body remains in the line.

In operation, the lever turns a cam inside an oil-resistant neoprene rubber cylinder, pressing the rubber against the valve body to produce shut-off. There is no sliding and therefore no abrasion, and only the malleable cast iron body and the rubber cylinder are in contact with the flow in the line. All internal parts are inside the rubber cylinder which is filled with grease. A half turn gives shut-off and when the valve is fully closed air in the down stream pipe is released automatically.

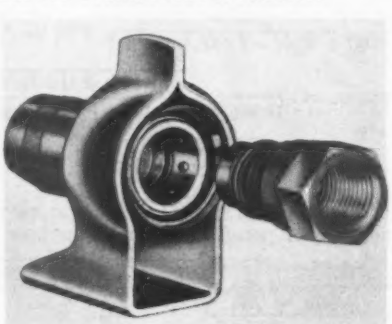


Claudo leak proof valve for gases and liquids.

Sizes range from ¼ in. to 2 in. bore. Air pressure drop through the valve is eqivalent to 4 ft of straight pipe. T valve is suitable for compressed air, other gases, and liquids. A perbunan (nitrile rubber) cylinder is used for petrol or fuel oils.

Coloured Nylon Tubing

In addition to their Tecalan black and natural nylon tubing, Tecalemit (Engineering) Limited, Plymouth, have now introduced a range of coloured tubing. This has the advantage that each line can be easily indentified when it is necessary for a number of lines to be grouped together and also the best colour can be selected to suit the background. The coloured tubes with an outside diameter of $\frac{3}{16}$ in. ¼, $\frac{5}{16}$ and ⅜ in. are available in blue, green, red, yellow and brown. The existing range of end fittings used for Tecalan tube is suitable.



SELF-SEALING COUPLING.—The new Aeroquip quick release self-sealing coupling for hydraulic lines of up to 3,000 psi operating pressure. The picture shows the coupling in the "break-away" bracket which, when fixed to a towing vehicle enables the coupling to break and seal automatically if an unexpected pull on the hose line is experienced. In this way, both hose and coupling are safeguarded from accidental damage.—Super Oil Seals & Gaskets Limited, Factory Centre, Birmingham 30

Strength of Plastic Pipes and Tubes

The mechanical properties of thermoplastic materials are markedly temperature dependent, also moduli are lower and strains higher than in the case of metals. Simple analysis assuming uniform stress distribution can, therefore, give misleading results. In particular the stressing of thermoplastic tubes for pressure rating demands the use of 'thick-walled' rather than 'thin-walled' formulae. Thermoplastic tube materials and their application to pressure rating are discussed

THE maximum working pressure for smooth bore thin-walled pipes and tubes in homogeneous material can be estimated with good accuracy by use of the Barlow formula, adopting a suitable value for maximum permissible working stress in the material within the limits of proportionality. Maximum working pressure can then be derived directly from:

$$P_w = 2S_p t/D$$

where P_w = maximum working pressure, psi
S_p = maximum permissible working stress for tube or pipe material, psi
t = thickness of pipe or tube wall, in.
D = overall diameter of pipe or tube, in.

The ratio between the ultimate tensile stress of the material and the permissible working stress S_p then gives the nominal safety factor. In the case of metallic tubes the safety factor allowed may be as low as 2·5 (although 3·0 is a more common minimum) and as high as 6·0, according to the nature of the service.

The Barlow formula is also used to determine the nominal pressure rating of tubes in thermoplastic materials—e.g. polythene, nylon, PVC, etc. It is usual in the case of plastic materials to adopt a minimum safety factor of 5·0 so that maximum permissible material stress is taken as 0·2 times the tensile stress at the rated temperature. Since the mechanical performance of these materials can vary widely with temperature it is strictly necessary to evaluate pressure ratings at a specific temperature as the loss of strength accompanying only a relatively small temperature change can drastically derate performance. In other words, the elastic constants of thermoplastics are much more temperature dependent than those of metals. At the same time their moduli are lower and in consequence the strains higher so that even with strains below the (apparent) elastic limit of the material the deformations involved may be too great for simple stress formulae to apply.

This represents a serious limitation to the applicability of the established Barlow formula for tubes since the validity of this formula depends on uniform stress throughout the wall thickness (as would normally be experience with a thin-walled tube), and that the material is not stressed beyond the elastic limit or limit of (linear) proportionality. As a consequence it is necessary, and standard practice, to evaluate the working strength of plastic tubes and pipes on purely empirical lines. One such method is to determine an experimental bursting pressure for a number of specimens (which may show considerable scatter), adopt one fifth of the mean (experimental) bursting pressure as the rated maximum working pressure, and proof test manufactured specimens to twice the rated maximum working pressure. Some reasonably accurate basis of 'formula' analysis is, however, obviously necessary in order to arrive at suitable original sizes (e.g. wall thickness required for a given bore size) rather than working on 'guesstimated' geometry.

The Barlow formula can be used for preliminary 'sizing', provided it is appreciated that the theoretical wall thickness will be an underestimate—i.e. the actual material stress produced by any pressure loading will be greater than the theoretical value. Further, it is unlikely that the stress will be constant throughout the wall thickness. A more accurate method of 'formula' analysis is to assume that all thermoplastic pipes and tubes behave as thick-walled pipes, irrespective of whether or not they are geometrically thin-walled (i.e. the ratio of the outside diameter to the wall thickness exceeds 16).

In the case of thick-walled tubing the stress in the material varies throughout the wall thickness, from a maximum at the bore to a minimum at the outer surface. The resultant stress is also more complex and can be regarded separately as comprising a radial compressive stress, a hoop tensile stress and an axial tensile stress. Corresponding formulae are summarized in Table I. The axial tensile stress case applies to a tube or pipe with

Table I.—STRESSES IN THICK-WALLED TUBING

Stress	Formula
Hoop Tensile Stress	$P \cdot \frac{R_2^2}{R_1^2 - R_2^2}\left(\frac{R_1^2}{R_2^2} + 1\right)$
Axial Tensile Stress	$P \cdot \frac{R_2^2}{R_1^2 - R_2^2}$
Radial Compression Stress	$P \cdot \frac{R_2^2}{R_1^2 - R_2^2}\left(\frac{R_1^2}{R_2^2} - 1\right)$

P = pressure
R_1 = outer radius of tube
R_2 = inner radius of tube

Table II.—MECHANICAL PROPERTIES OF PVC SHEET *

Property	Value
Conventional Compressive Strength	10 300 psi
Yield Strain in Compression	5%
Calculated True Compressive Strength	9 800 psi
Conventional Tensile Yield Strength Estimated	9 300 psi
Measured Tensile Yield Strength	8 300 psi

* I.C.I. Plastics Division.

closed ends. Comparing with the Barlow formula it will be seen that the difference in hoop tensile stress is in the ratio $(R_1^2 + R_2^2)$: $R_1 (R_1 + R_2)$.

Which conditions of failure apply may depend upon the particular application of the tube or pipe. In critical cases it may be necessary to evaluate all three stresses separately to see which is the greater; or specifically against a minimum failure condition which can be tolerated. Hoop and axial stresses are tensile in character and can thus be based on the tensile stress of the material. The radial compressive stress must be evaluated against the compressive strength of the material which is not always known. It appears generally satisfactory however, to assume that this will be similar to the tensile yield strength of the material. The latter is a *true* stress figure obtained by dividing the load by the *actual* cross section under load. The equivalent 'conventional' compressive stress will usually be some 10% to 15% higher than the 'conventional' tensile yield strength because of the high yield strain associated with thermoplastic materials—see also Table II.

A practical formula for thick-walled tubing derived from the above considerations of complex stress is:

$$t = \frac{D}{2}\left(\sqrt{\frac{S_p + P_w}{S_p - P_w}} - 1\right)$$

where P_w = working pressure
S_p = maximum permissible working stress in the tube material

Table III shows comparative results obtained by calculating theoretical wall thickness by both the Barlow formula and the 'thick-walls' formula above against a standard range of polythene tubes, performance figures for the latter being established largely on empirical lines.

Polythene has many advantages as a tube material but must be regarded as having a strictly limited temperature range for pressure working. Normal polythene has a tensile strength of 1400—1800 psi at 20° C, reducing approximately 40% at 30° C. It is not considered satisfactory for pressure working at higher temperatures although a maximum service temperature of 60° C is permissible in the absence of any appreciable static pressure. A considerably better mechanical performance. is realised with high-strength polythene where the tensile strength at 20° C is of the order of 3,000—3,500 psi. The softening and melting points are also some 30° and 20° C higher, respectively, and hence the possible working range can be extended by some 10°-15° C. However, strength falls rapidly with increasing temperature and pressure working is not normally recommended above 30°-35° C. Typical values for maximum permissible working stress in the material (at 20° C) are 300-350 psi for normal polythene and 600-700 psi for high-strength polythene.

PVC is another thermoplastic with a strictly limited range of service temperatures. Flexible PVC has a tensile strength of the order of 1500-2000 psi at 20° C and is not normally rated or recommended as pressure tubing although it can well be used for relatively low pressures where the maximum service temperature does not exceed 20° C. The maximum permissible material stress for pressure rating at this temperature is of the order of 300-350 psi.

The more logical choice for pressure rating is high impact PVC which is a rigid form of the plastic obtained by modification and produced in a range of blends. Average tensile strength of typical high-impact PVC is of the order of 6000 psi at 20° C, giving a maximum permissible material working stress for pressure rating of 1000 to 1200 psi at that temperature. Maximum service temperature (for pressure rating) is 50° C, with permissible material stress progressively decreasing with increase of temperature above 20° C. The pressure rating of proprietary high impact PVC pipes and tubes is also usually based on the method of jointing, e.g. whether used with plain cemented socket joints or with screwed joints (the latter tubing having a thicker wall for the same pressure rating).

For higher pressure work, and particularly to compete with metallic tubes nylon becomes a logical material choice since the tensile strength offered by the various polymers, copolymers and blends ranges from about 6000-12 000 psi. In general, two basic grades are employed for pressure tubing a flexible grade for flexible delivery lines etc., and a harder semi-rigid grade for static applications. In addition, temperature dependency is less marked and nylon can be used up to a maximum service temperature of about 100° C (with appropriate derating). Nylon also undergoes relatively little creep or cold flow at the more elevated temperatures and exhibits good fatigue life with excellent resistance to flexing and vibration.

Depending on the grade of nylon, maximum permissible material stress may be as high as 2000 psi at 20° C, although the majority of nylon pressure tubing is usually rated on a slightly lower figure—e.g. 1750 psi. Thus it is readily possible to produce practical sizes of tubing capable of being rated in the high pressure range (e.g. 2000-2500 psi) as well as the medium pressure range (typically 500 psi). A further development with nylon has been the appearance of woven-reinforced (braided) nylon hose for high pressure work. An interesting point here is that the excellent fatigue properties of the nylon core (tube), with suitable braiding reinforcement, produces a hose which is virtually free from fatigue effects and loss of performance and hence it can be rated for working at a comparatively low safety factor—e.g. 2·5 is a pefectly safe figure.

Of the other thermoplastic tube and pipe materials PTFE is, of course, a standard 'core' tube material for high-duty flexible hose, but little use is made of the plain tube material (unreinforced) compared with the application of other thermoplastic tubes. Some of the modern 'nylon alternatives' such as propopylene, polycarbonate and polyacetal, have still to be evaluated as 'tube' materials where their specific properties might be put to advantage —e.g. better dimensional stability than nylon or resistance to chemicals which attack nylon. Undoubtedly, too, much more will be made of thermoset plastic tubes of the glass fibre variety which at present are mainly confined to production of the larger diameter sizes, but could equally well be attractive as small bore tubes if costs are competitive.

Table III.—HIGH STRENGTH POLYTHENE TUBES

Bore	Nominal o/d	Wall Thickness	Max. Working Pressure	Theoretical Wall Thickness for same Working Pressure	
				Thin-walled* Formula	Thick-walled* Formula
in.	in.	in.	psi	in.	in.
¼	0·686	0·093	30	0·113	0·139
½	1·000	0·125	200	0·143	0·171
1	1·250	0·125	150	0·134	0·153
1¼	1·500	0·125	130	0·139	0·156
1½	1·750	0·125	120	0·150	0·166

*Based on maximum permissible material stress of 700 psi

Deflexion of Uniform Beams

Concluding part of a collection of reference material tabulated in a uniform method

By W. H. SHEPPARD, B.Sc.(Eng.)

II. Uniformly Distributed Loads

Cantilever.—As for the concentrated load, the case may be dealt with from either end. The load being distributed however, powers are increased.

From the support $S = -w(L-x)$
From the free end $S = wx$

and successive integration gives the results indicated.

Pinned beam.—This case may be dealt with from the support or from the centre. Since there is no discontinuity, both methods are universally applicable. The deflexion as from the centre was calculated from that obtained from the support and other values by differentiating. The latter may be checked from the support values but signs for S and θ must be adjusted.

Clamped beam.—This case is dealt with in a similar manner by integrating the expression for shear force. The value of m is determined by:

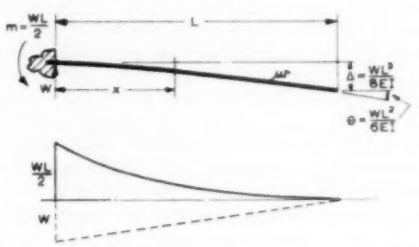
$$x = L,\ dy/dx = O,\ m = WL/12$$

Point of inflexion is determined (as for other cases) by considering.

$$dy^2/dx^2 = O$$

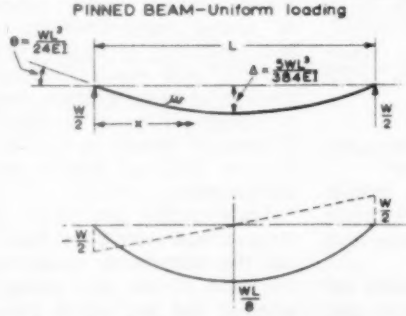
Clamped/pinned beam.—This case may be regarded from either end, using standard equations and boundary conditions. Alternatively, the beam may be regarded as a cantilever re-deflected by the support at the pinned end. It is not possible to calculate the deflexion directly from energy considerations, but results may be checked by equating the total strain and deflexion energies by integrating both expressions.

CANTILEVER – Uniform loading



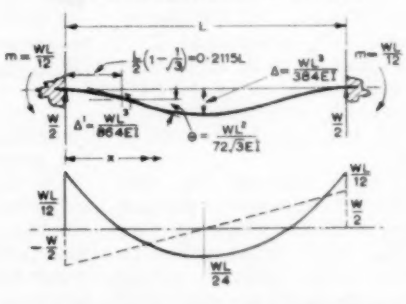
	FROM SUPPORT	FROM FREE END
S	$-w(L-x)$	wx
M	$\frac{w}{2}(L-x)^2$	$\frac{wx^2}{2}$
θ	$\frac{w}{6EI}(3L^2-3Lx+x^2)$	$-\frac{w}{6EI}(L^2-x^2)$
δ	$\frac{wx}{24EI}(6L^2-4Lx+x^2)$	$\frac{w}{24EI}(3L^2-x^2)(L^2-x^2)$

PINNED BEAM–Uniform loading

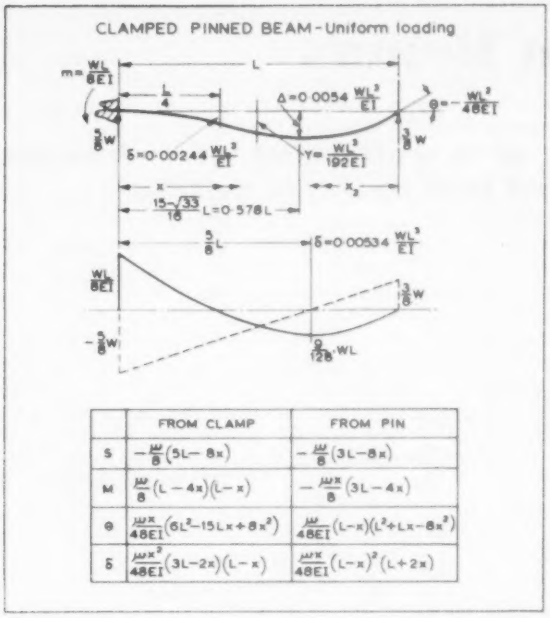


	FROM SUPPORT	FROM CENTRE
S	$-w\left(\frac{L}{2}-x\right)$	$\pm wx$
M	$-\frac{wx}{2}(L-x)$	$-\frac{w}{2}\left[\left(\frac{L}{2}\right)^2-x^2\right]$
θ	$\frac{w}{24EI}\left(L^3-6Lx^2+4x^3\right)$	$\mp\frac{wx}{6EI}\left[3\left(\frac{L}{2}\right)^2-x^2\right]$
δ	$\frac{wx}{24EI}(L-x)(L^2+Lx-x^2)$	$\frac{w}{24EI}\left[\left(\frac{L}{2}\right)^2-x^2\right]\left[5\left(\frac{L}{2}\right)^2-x^2\right]$

CLAMPED BEAM–Uniform loading



	FROM SUPPORT	FROM CENTRE
S	$-w\left(\frac{L}{2}-x\right)$	$\pm wx$
M	$\frac{w}{12}\left(L^2-6Lx+6x^2\right)$	$-\frac{w}{6}\left[\left(\frac{L}{2}\right)^2-3x^2\right]$
θ	$\frac{w}{12EI}(L-2x)(L-x)$	$\mp\frac{wx}{6EI}\left[\left(\frac{L}{2}\right)^2-x^2\right]$
δ	$\frac{wx}{24EI}(L-x)^2$	$\frac{w}{24EI}\left[\left(\frac{L}{2}\right)^2-x^2\right]^2$



	FROM CLAMP	FROM PIN
S	$-\frac{W}{8}(5L-8x)$	$-\frac{W}{8}(3L-8x)$
M	$\frac{W}{8}(L-4x)(L-x)$	$-\frac{Wx}{8}(3L-4x)$
θ	$\frac{Wx}{48EI}(6L^2-15Lx+8x^2)$	$\frac{W}{48EI}(L-x)(L^2+Lx-8x^2)$
δ	$\frac{Wx^2}{48EI}(3L-2x)(L-x)$	$\frac{Wx}{48EI}(L-x)^2(L+2x)$

Q values.—For comparative purposes, the reciprocal deflexion coefficients are tabled below, the value Q being used by the author.

Let $\Delta = WL^3/QEI$

where Δ = deflexion at application of load (not necessarily greatest value)

Beam	Concld. Load	Distd. Load
Cantilever	3	8
Pinned beam	48	384/5
Clamped beam	192	384
Clamped/pinned beam	768/7	192

Conclusion

As stated in the introduction, the main purpose has been to give results in a concise manner for quick reference and to this end academic discussion has been cut to a minimum, and salient values are given on the deflexion diagrams. Equations are tabulated in order that alternative approaches may be compared and the most suitable formula chosen for a particular purpose. Bending moment and shear force diagrams are superimposed in line with the deflexion diagrams so that their implication may be observed.

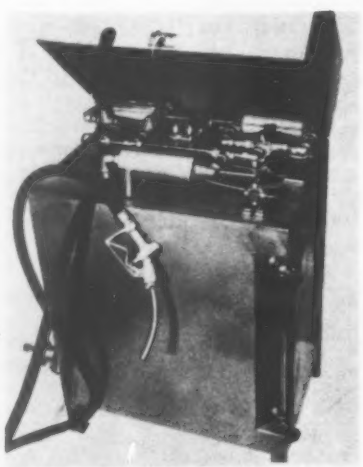
Liquid Blending

The blending machine to suit a wide variety of industrial processes produced by Suba Hydraulics Limited, 86 Lind Road, Sutton, Surrey, is designed to bring together two or more liquids in a prearranged proportion through a diffuser chamber just before delivery; it eliminates the problems usually associated with pre-mixed blends such as settling out while in the storage vessel and intermediate tanks and pumps.

The original model illustrated here was specially produced for the Ford Motor Company Limited for the rapid filling of radiators with a mixture of water and anti-freeze. It delivers 75% water and 25% anti-freeze and by micro-adjustment of the cylinders a range of 84% water and 16% anti-freeze to 67% water and 33% anti-freeze can be achieved.

Mains water pressure has been used as the motive power to energize the water cylinder which in turn drives the other liquid cylinders. For other blends different liquids under pressure could be used or, if desirable, air pressure. The unit is interlocked through each liquid to cause a standstill should the operator allow any of the liquids to run dry.

It is only a matter of cylinder composition and adjustment to achieve an unlimited range of varying proportions to make any desired blend. The liquids fed into the reservoir compartments can be pump fed, gravity fed or from barrel.



Specially produced for the Ford Motor Company Limited this blending machine is used for the rapid filling of radiators with a mixture of water and anti-freeze

On a unit which has to handle inflammable liquids the complete elimination of electrical units can be arranged.

All liquid handling cylinders are in brass; end castings, pistons and valves are in bronze and the pipes and fittings are copper and galvanized steel. The tanks and cover are mild steel, all welded. The inside of the tank is treated with alcohol resisting dressing and the outside of the tank and non-moving parts are finished hammer blue. If necessary the complete unit can be made in stainless steel wherever contact is being made with the liquid being handled.

Refractory Coating

The increased use of fuel oil burning in furnaces—in industry and on ships—has resulted in a need for heavy duty refractory coatings to withstand the action of the acids produced by fuel oil on the fire-bricks, arches, etc. The Furnascote range of refractory coatings made by Corrosion Limited, Malvern Road, Southampton, consists of Highglaze, Nonvit and Mortar. These contain high proportions of zircon compounds to give a heat resistance of up to 1910° C or 3500° F, and greater resistance to damage of brick work by free acids or alkalies. Also of interest is that Furnascote creates a barrier $\frac{1}{16}$ in. to $\frac{1}{8}$ in. thick of highly refractory compounds.

Tests carried out on oil tankers showed that after three years use at sea the continuous movement and vibration of the ship riding rough weather did not crack Furnascote coatings. Furnascote can also be used to prevent breakdown in factories where the same problem of vibration occurs.

Furnascote costs 1s. 9d. per lb, in the form of a dry powder, in 56 lb polythene lined drums, to which water can be added by the user.

Optimum Performance with Bolts and Screw Fasteners

Standard head forms often show a considerable variation in the relationship which can be achieved between potential bolt performance and limiting bearing stress where the material begins to deform under the bolt head. Hole diameter is equally important as small diameter socket head screws will often pull completely through soft materials when used without back-up washers. Factors concerning optimum design are discussed in this article

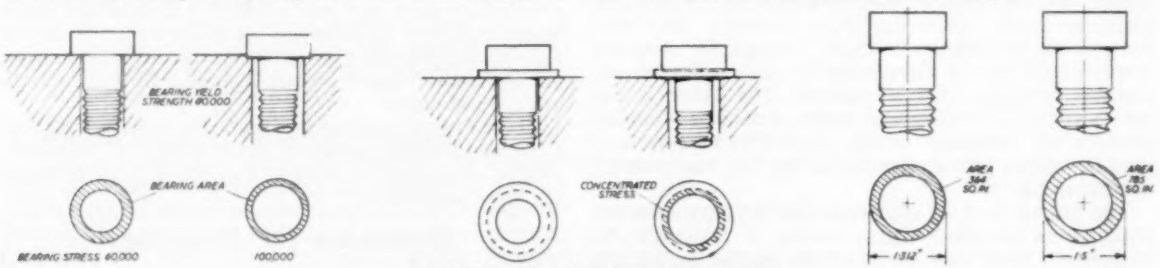
THE bearing stress in a bolted assembly is obviously related to the bearing area achieved under the bolt head. This, in turn, depends both on the diameter of the bolt head and the diameter of the hole. The former is a standardized dimension, relative to the bolt diameter. Hole diameter is a variable design factor, depending on the clearance allowed for assembly. An oversize hole (or an undersize bolt used in a specified hole) can so reduce the bearing area that the bearing stress realised on tightening exceeds the bearing yield strength of the material being bolted up—see Fig. 1. This means that the bolt head will indent into the material, causing loss of tightness of the assembly and limiting the axial tensional loading which can be applied. In extreme cases the material may flow to such an extent that the bolt is pulled right through the hole. It is readily possible, for instance, for socket head screws to pull right through a slightly oversize hole in a relatively soft material such as aluminium or brass.

Normal practice to guard against such a possibility is to back up the bolt head with a washer somewhat larger in diameter than the head, the washer being harder than the material being bolted. This reduces the bearing stress by distributing the bearing load over a wider area. It still does not necessarily produce a completely 'tight' joint with a badly oversize hole, however, as there may still be a concentration of stress at the edges of the hole—Fig. 2. Again the material can be deformed as a consequence, with loss of performance.

Where any deformation takes place, such as the material indenting or flowing into the clearance space between bolt and hole diameter, there is inevitably a loss of holding power. The desired initial tightening cannot be achieved without danger of pulling the bolt right into the material and much of the tightening energy is lost in friction produced in causing the material to flow plastically. The loss is even more significant in the case of dynamic loading, for susceptibility to fatigue failure is greatly increased.

Unless the hole diameter is excessively oversize relative to the specified bolt diameter, employment of a sufficiently hard washer will probably provide a practical solution, although not necessarily a good one from the point of view of fatigue resistance. The use of a larger bolt of better fit is another alternative, at the expense of increased weight and cost and uneconomic design. In other words, if the original bolt size was right on the score of load carrying performance, any larger size is underrated and thus uneconomic in performance. To accommodate a standard (larger) size the original hole may even have to be enlarged, which can introduce problems of stress concentration due to the greater cut-out area encroaching on ends or edges, in certain designs.

The further alternative is an expensive one—reproportioning the bearing area of the bolt head to suit. The problem does not normally arise with conventional hexagon head bolts, provided the initial size is correctly chosen to limit bearing stress to a figure consistent within the bearing yield stress of the material and ensuring that the required bearing area is given (by specifying a suitable maximum o/d size for the hole which is not exceeded). It is more likely to occur when



Figs. 1, 2 & 3.—Effect of bolt clearance on bearing area

ANALYSIS OF A RANGE OF SOCKET HEAD BOLTS *

SATISFACTORY			FAIR			CAPABLE OF IMPROVEMENTS				
Thread Size	Head Dia	Max. Bearing Area	Thread Size	Head Dia	Max. Bearing Area	Thread Size	Head Dia	Max. Bearing Area	Increased Head Dia	Increased in usable Strength
in.	in.	sq in.	in.	in.	sq in.	in.	in.	sq. in.	in.	
$\frac{1}{4}$	0·375	0·041	$\frac{5}{16}$	0·625	0·116	$\frac{3}{8}$	0·438	0·047	0·468	54%
$\frac{3}{8}$	0·562	0·102	$\frac{7}{16}$	0·812	0·209	$\frac{1}{2}$	0·875	0·203	0·937	51%
$\frac{1}{2}$	0·750	0·188				$\frac{5}{8}$	1·000	0·223	1·125	94%
						$\frac{3}{4}$	1·125	0·254	1·312	134%
						1	1·312	0·364	1·500	117%

* *'Design News'*

using socket head screws which tend to have a relatively small bearing area of purely annular form. Particularly with the increasing use of high tensile materials for these screws, which enable high loadings to be achieved on the threads, there has arisen the need to increase the head diameter above the original standard.

The increase in performance possible with only a relatively small increase in head diameter is quite remarkable. A typical minimum bearing yield strength for cast iron, for example, is 80,000 psi. Any bearing load greater than this will indent the surface. The load which can be applied by any screw or bolt is thus readily calculated by multiplying this figure by the actual bearing area available.

In the case of a 1 in. dia socket head screw a standard head diameter is 1·312 in. giving a maximum bearing area of 0·364 sq in. Maximum bearing load is thus 80,000 × 0·364 = 29,100 lb. An increase in head diameter to 1·5 in. (14·3% increase) gives a maximum bearing area of 0·785 sq in., corresponding to a maximum bearing load of 80,000 × 0·785 = 63,000 lb. In this case the maximum axial load possible has been increased from 29,100 to 63,000 lb (117%) for an increase in head diameter of 14·3%—Fig. 3. In other words the possible strength as regards bearing of the bolted assembly has been increased by a factor of 2 for the same thread diameter.

The actual realisable load is, of course, still dependent on the hole diameter. The greater the clearance between bolt and hole the smaller the actual bearing area available and thus the less the realisable strength. Bearing area is also still further reduced where the screw is tightened in a slot (to allow for position adjustment of two components) rather than a plain hole. In all such cases the larger screw head shows to advantage and can eliminate the otherwise strict necessity for employing back-up washers.

Logically, the head diameter (and thus the resulting bearing area) of any bolt should be proportioned to give a consistent and high percentage of the thread loading stress available as tightening load, regardless of diameter. This does not necessarily follow with standard bolt head proportions. Some sizes may be relatively weak in respect of the tightening load which can be applied to realise the bearing yield stress of the material being jointed (because of a relatively low bearing area for that particular size). Others may have 'oversize' head proportions in that they will shear through the threaded length or fail at the threads before the maximum permissible bearing stress is realised. The latter is not necessarily a bad feature and, in fact, would be commonplace in an 'optimum' design of general purpose bolt used in contact with a material having very high bearing yield strength.

The trouble here, of course, is that the same standard head forms are used with a variety of materials. An 'optimum' head size designed to realise a suitable performance in contact with a softer material will have an 'oversize' head for similar performance in bolting up a harder material. Equally, a head size proportioned for a material with a high bearing yield strength will indent into a softer material before full tightening of the bolt is realised. To adopt different head proportions for different materials would be good 'design', but poor from the point of view of production and cost, to say nothing of the extravagant increase in number of standards. In the case where a bolt or screw is specifically designed for a purpose and produced as a special, however, it can be correctly proportioned as regards head size on the bearing stress parameter. In other cases, analysis of actual bearing loads involved with the use of standard production fasteners can show whether or not a back-up washer is required, limits on tightening torque set by the bearing load as well as thread load, and how much of the potential strength of the fastener is usable. For dynamic loadings, at least, failure to use the full tightening capabilities of a bolt or screw which is otherwise 'correct for size' is the cause of nearly all failures which do occur. Utilising the full potential of the fastener strength by proper attention to bearing load and achieving a bearing stress approaching that of the stress in the threads also means a minimum size and number of fasteners for suitable static performance, offering savings in cost and weight.

Copper Micro-Wire

A new process makes possible the production in Great Britain of copper wire as fine as three microns, or 0·00012 in. dia. The basic principle utilises the natural tendency of glass to be drawn into a filamentary thread when heated to a fully plastic state. By maintaining molten copper inside a glass tube under these conditions, it too becomes drawn out to an even smaller diameter than surrounding glass. The glass also serves as an insulating sheath and tests show that it is able to withstand a d.c. voltage in the region of 5,000 volts. This copper micro-wire has many specialised applications in the field of electronics and particularly in the present trend of miniaturisation of radios, hearing aids and similar items. A more detailed and illustrated description appears in the current Spring edition of "Copper", journal of the Copper Development Association, 55 South Audley Street, London W1.

Rubber Wheel Grooves and Tyres

Prescollan polyurethane rubber is a very tough elastomeric material with a resistance to abrasion and tearing five times better than the best natural rubber. When used for solid tyres its high load carrying capacity permits more efficient tyre design, smaller wheels and saving in power and life. It is suitable for use in temperatures as low as −35° C and as high as 80° C. It is unaffected by most oils and solvents and does not mark floors. Another valuable use of the material is in the form of low-friction grooved coverings for rope pulleys, an application which greatly increases the life of both pulleys and ropes.

These Prescollan tyres are supplied by John Bull Rubber Company Limited, Leicester, either bonded to customers' centres or supplied bonded to a standard range of bands for press application.

Insurance for Inventors

TO THE EDITOR OF MECHANICAL WORLD

Sir,—You have rendered a service to inventors in publicising the news of a company being formed to foster and to encourage inventors to persevere with their ideas and ambitions, expectant of fulfilment and merit in the measure of time.

The inventors' lot in this country has on average been a sad one, because in the main they have been neglected, and for the very reasons stated in your editorial.

Birmingham. Francis B. Willmott.

Research and Power Reactors in Canada—II

—a review of progress

By J. R. FINNIECOME, M.Eng., M.I.C.E., M.I.Mech.E., F.Inst.F., Consulting Engineer

5. AECL Nuclear Research and Power Reactor Programme

The projects are indicated below:

(a) The basic design of the 200 MW (thermal) reactor NRU was completed and went critical on November 3, 1957 and was operating at full power on April 7, 1958.

(b) A slightly modified version of NRX was built for India, known as CIR (Canada-India Reactor). It was installed at Trombay, near Bombay, and went critical on July 29, 1960.

(c) A 20 MW (electric) Demonstration Reactor (NPD-2) is under construction and will be located at Rolphton, near Ontario Hydro Des Joachims plant, about 16 miles from Chalk River.

(d) A 200 MW(E) large scale nuclear power station, designated CANDU (Canada Deuterium Uranium Reactor) is under construction at Douglas Point, on Lake Huron, nine miles from Kincardine, Ontario.

(e) A zero energy reactor, ZED, for lattice experiments for CANDU, similar to ZEEP but a larger thermal rating, i.e. 100 W went critical on September 7, 1960. It uses natural uranium as fuel and heavy water as moderator.

(f) An organic liquid cooled deuterium reactor (experimental), OCDRE, having a thermal rating of 31·5 MW and located at the new research centre Whiteshell, near Winnipeg, Manitoba. It is used for research in connexion with the OCDR power reactor. The organic liquid coolant selected is Santawax OM70.

(g) A 150 MW(E) nuclear power station using an organic liquid cooled deuterium reactor (OCDR) is being designed by the Canadian General Electric Company Limited.

6. Research reactor at McMaster University

This University is at Hamilton, Ontario. The enriched uranium, light water, swimming pool reactor is used for conducting advanced nuclear research and for material testing. It is designated MNR and has a thermal rating of 1 to 5 MW. AMF Atomic (Canada) Limited (Reactor) were responsible for the design and the construction. This research and training reactor has been in operation since it went critical on April 8, 1959. This university is at present the only university to have its own reactor.

7. Canada's new nuclear research centre

As the establishment at Chalk River had reached a dangerous size the AECL decided to build a new centre at the re-named Whiteshell in the Province of Manitoba, where it is proposed to develop the natural uranium, heavy water moderated and organic cooled power reactor (OCDR).

8. Summary of general particulars

The general information of the eight research and the three power reactors is contained in Table I, item 1 to 11 inclusive. Item 6 gives details of the Canada-India reactor (CIR). The essential technical data of the research reactors ZEEP, NRX, NRU and PTR at Chalk River, MNR at McMaster University and CIR at Trombay, India, are summarized in Table II, columns 3 to 8 inclusive. Similar details on the power reactors NPD-2 and CANDU will be given in a future issue (Tables III and IV). On examining the contents of these tables one finds that:

(a) Canada has seven research (six in operation and one under construction) and three power reactors being developed (NPD-2, CANDU, OCDR).

(b) Eight of ten reactors have natural uranium as fuel and heavy water as moderator. The other two are of the swimming pool type, using enriched uranium as fuel and light water as moderator.

(c) Two of the power reactors (NPD-2 and CANDU) are cooled by heavy water whilst the latest (OCDR) is to have as coolant an organic liquid (Santawax).

(d) The maximum rating of the turbogenerator set for CANDU is 220 MW, which is the second largest in the world to be installed in a nuclear power station, the speed being 1,800 rpm. The largest is the 275 MW set at Indian Point nuclear power station, near New York. It is also designed to run at the same speed. The operating conditions of CANDU and Indian Point are:

	CANDU	INDIAN POINT
Steam pressure at turbine stop valve (psig)	565	355
Steam temperature at turbine stop valve (°F)	482	1000
Vacuum at turbine exhaust (in Hg)	29	28·5
Wetness at turbine exhaust (%)	—	5·9
Final feed temperature (°F)	430	332
Number of feed heating stages	6	4
Number of flows at the turbine exhaust	2	2
Maximum length of the last row of blades	—	44 in.

9. Costs of the "CANDU" Station

The total cost including engineering, erection, interest and commissioning amounts to $81,507,000 (£29,200,000) For a net electric rating of the station of 203 MW(E)

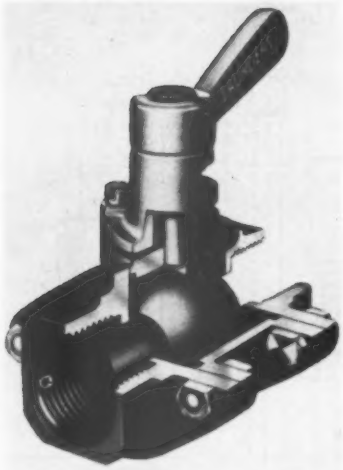
this corresponds to $402 per kW (net) £144 per kW (net)). The actual construction is estimated to cost about $50 million (£17·95 million). This would give a cost per kW (net) of $246·5 (£88·5). The details of the cost of some the most important items are:

	$ million	£ million
(a) Reactor, heat exchangers and auxiliaries	11·196	4·02
(b) Turbogenerator set and auxiliaries...	7·145	2·56
(c) Heavy water and helium...	11·677	4·18
(d) Engineering	8·150	2·92
(e) Electrical and instruments	6·100	2·19
(f) Interest during construction (at 5¾%)	9·198	3·29
(g) Initial fuel charge ...	4·600	1·65

To be continued.

Table II.—SUMMARY OF ESSENTIAL DATA OF CANADA'S NUCLEAR RESEARCH REACTORS

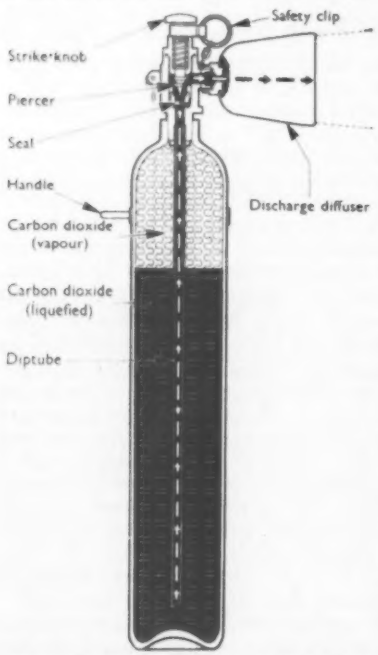
1	2	3	4	5	6	7	8
1	Designation	ZEEP	NRX	NRU	PTR	MNR	CIR
2	Location	Chalk River Ontario	Chalk River Ontario	Chalk River Ontario	Chalk River Ontario	McMaster University Hamilton, Ontario	(Canadian-Indian Reactor) Trombay, near Bombay, India
3	Type of reactor ...	natural uranium heavy water moderated, no cooling (tank type)	natural uranium heavy water moderated, light water cooled, (tank type)	natural uranium heavy water moderated and cool (tank type)	enriched uranium light water moderated and cooled (swimming pool type)	enriched uranium light water moderated and cooled (swimming pool type)	natural uranium heavy water moderated, light water cooled (tank type)
4	Thermal rating ...	10 W	40 MW	200 MW	10 to 100 W	1 to 5 MW	40 MW
5	Date first critical ...	5.9.45	22.7.47	3.11.57	29.11.57	8.4.58	
6	Date on full rating ...	5.9.45	17.5.48	7.4.58	29.11.57	8.4.58	
7	Moderator	heavy water	heavy water	heavy water	light water	light water	heavy water
8	Coolant	none	light water	heavy water	light water	light water	light water
9	Fuel						
	(a) Type	natural uranium	natural uranium	natural uranium	enriched uranium	enriched uranium	natural uranium
	(b) Enrichment ...	nil	nil	nil	90% U235	90% U235	nil
	(c) Normal fuel charge	5·5 tonne	10·5 tonne	11 tonne	2·61 kg U235	4·26 kg U235	10·5 tonne
	(d) Specific rating (kW/kg) ...	—	—	—	0·5% of initial U235 0.038	15% 234	—
	(e) Expected average burn-up before processing ...	—	3·8	18·2			3·8
10	Fuel element						
	(a) Type	cylindrical rods	cylindrical rods	plates	plates	plates (MTR type)	cylindrical rods
	(b) Fuel alloy ...	natural uranium	natural uranium	natural uranium	U-Al alloy	U-Al alloy (10·8 gm U235/plate)	natural uranium
	(c) Cladding thickness	0·0394 in.	0·080 in.	0·0394 in.	0·020 in. on each side	0·015 in.	0·0394 in.
	(d) Cladding material ...	aluminium	aluminium	aluminium	aluminium	aluminium	1S aluminium
	(e) Type of sub-assembly ...	cylindrical one	cylindrical one rod per lattice pitch	flat strips in tubes 5	parallel plates 10	parallel plates (stacked) 18	individual rod one rod per lattice pitch
	(f) Number of fuel elements per sub-assembly ...						
	(g) Number of sub-assemblies ...	25	192	201	17	24	192
	(h) Total number of fuel elements ...	25	192	1005	170	432	192
	(i) Dimensions of fuel elements ...	1·28 in. dia, 6 in. long stacked in 9 ft 6 in. long tubes	1·36 in. dia, 10 ft long	1·34 in., 2·08 in., 2·26 in. wide 0·157 in. thick, 9 ft 10 in. long	2⅛ wide, 0·020 in. thick 2 ft long	2·5 in. wide, 0·020 in. thick, 23·5 in .long	1·36 in. dia, 01 ft long
	(j) Dimensions of subassembly ...		1·84 in. dia, 12 ft 6 in. long	2·48 in. dia, 12 ft long	3 in. × 3 in. × 2 ft 6 in.	3 in. × 3 in. × 34⅛ in.	1·84 in. dia, 12 ft 6 in long
	(k) Normal life of assembly ...		9 months			3 yrs	330 days
11	Core						
	(a) Overall dimensions	6 ft 9 in. dia, 8 ft 6 in. long	8 ft 9 in. dia, 10 ft 6 in. long	10 ft 2 in. dia 9 ft 10 in. high	11·8 in. square, 2 ft long	18 in. × 12 in., 2 ft long	8 ft 9 in. dia, 8 ft 11 in. long
12	Core containment vessel						
	(a) Overall dimensions	6 ft 9 in. dia, 18 ft 6 in. deep	8ft 9 in. dia, 11 ft high	11 ft 6 in. dia, 12 ft high	15 ft wide, 16 ft long 20 ft 6 in. deep (pool)	15 ft wide, 40 ft long 30 ft deep (pool)	8 ft 9 in. dia, 10 ft 6 in. high
	(b) Material ...	aluminium	aluminium	aluminium	concrete	concrete	aluminium
	(c) Mean operating pressure ...	atmospheric	5 psi	24·2 psia	atmospheric	atmospheric	5 psi
	(d) Mean operating temperature (°F)	room	122	140	room	95	140
13	Primary coolant						
	(a) Type of coolant	none	light water	heavy water	light water	light water	light water
	(b) Normal flow ...	—	220 kg/sec	2,000 kg/sec	—	900 gmp	366 kg/sec
	(c) Mean velocity ...	—	22 ft/sec	29·5 ft/sec	—	—	19·7 ft/sec
	(d) Inlet temperature (°F)	—	50	120·2	—	95	122
	(e) Outlet temperature (°F) ...	—	104	167·0	—	101	167
	(f) Rise in temperature (°F) ...	—	54	46·8	—	6	45
14	Method of heat dissipation ...	natural convection	water from Ottawa River	8 heat eachangers secondary coolant river water	—	heat exchanger for primary loop, secondary cooling tower	heat from primary coolant removed by sea water
15	Biological shield ...	water and concrete	concrete, 8 ft thick	concrete, 9 ft, 10 in. thick	light water, 14 ft above top of core	barytes concrete and 26 ft over the core	concrete, 5 ft 10 in.



BALL PLUG VALVE.—The range of ball plug valves made by Saunders Valve Company Limited, Cwmbran, has been extended to include a 4-in. size. The valves have a quarter-turn action and when open present a full, straight bore. The flexible seats tighten the seal as the pressure rises

CO_2 Extinguisher

The leak-proof, strike-knob 5 lb carbon dioxide fire extinguisher, Model 1505, being made by Nu-Swift Limited, Elland, Yorkshire, is mainly intended for fighting inflammable liquid fires, and fires involving electrical equipment indoors. The extinguisher has a mean range in still air of 11 ft, the carbon dioxide being expelled, for 8 sec at 65°F, through a novel type of discharge diffuser. Designed for fire fighting at close quarters, in the hands of an inexperienced fire fighter it is capable of putting out a 6 sq ft inflammable liquid fire. In the case of an experienced fire fighter, the corresponding figure is 9 sq ft.



Diagramatic drawing of the 5 lb. Nu-Swift carbon-dioxide extinguisher. Note the strike knob principle which prevents leakage

Carbon dioxide, although much less efficient for fire fighting than dry powder, is non-damaging in use and leaves no residue, and can be made to penetrate into places which are inaccessible to other fire-fighting media such as laboratories and operating theatres; it can also be used in fires involving fine chemicals or complicated electrical or electronic equipment ashore or on board ships.

Its small weight of 19½ lb enables the extinguisher to be handled comfortably by women, while it can be reloaded on the spot in 60 sec by any competent person. It is operated in the upright position. The model has been approved by the Ministry of Transport (Marine Section) for use on merchant vessels

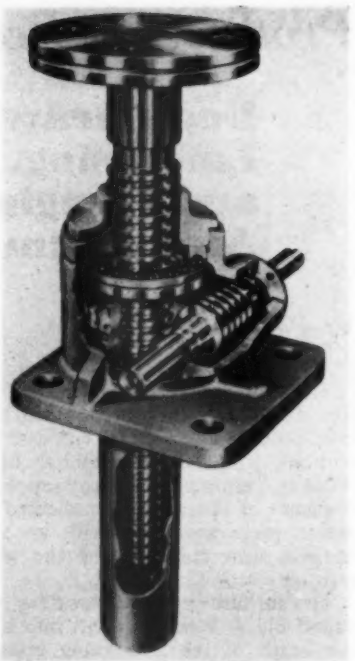
Worm Gear Jacks

The standard range of worm gear jacks, known as the Duff Norton 1800 series consists of eight units with capacities from two to 100 ton and was specifically designed for building into machinery and equipment where jacking duties are involved. The makers are Consolidated Pneumatic Tool Company Limited, 32 Dawes Road, London SW6.

Being mechanical in operation, the jacks can be connected by means of shafting and mitre gear boxes to lift in unison, even with an unevenly distributed load. They are self-locking and can be used to hold loads of several hundred tons in position indefinitely without creep occurring.

Features common to all jacks in the range include the use of heat treated phosphor bronze worm gear teeth, the use of Alemite grease nipples and the absence of keying in the lifting screw, allowing the top to be bolted to the member being raised, this preventing the jack from turning. A clockwise rotation is employed for lifting the load, the maximum worm gear speed being 500 rpm. In the smallest and two largest jacks in the range a ball race and grease seal is fitted at each end of the worm, whilst for jacks of from 5–25 ton capacity, Timken taper bearings are used for this duty.

The closed height of the range lies between 5¼ in. for the 2 ton model and 24 in. for the 100 ton unit. The base measurements increase in eight stages, according to the size of the model from 3½ in. × 7 in. for the smallest jack to 20¾ in. × 24¼ in. for the largest unit. The weights of the range, based on a 6 in. lift lie between 17 and 1200 lb, the extra weight of each additional 1 in. of lift in these sizes being 0·33 lb and 9 lb. Whilst the standard range can be supplied with lifts of up to 24 in., greater lifts can be supplied where required.



Sectional view of a Duff Norton worm gear jack

Apart from their use as lifting jacks, the units in this range may be employed as linear actuators, to push or pull horizontally and to apply pressure in any required direction. For any of these duties, they may be either manually or motor operated and since all units have a common lifting speed, any combination of sizes may be employed together, operated through gear boxes and shafting from a common power source.

Superthane Castors

Heavy duty castors with superthane treads are offered by Flexello Castors & Wheels Limited, Slough. Superthane is basically a polyurethane elastomer which will support four times the load of good quality rubber and will last ten times as long. It is also oil and chemical resistant.

Production Practice:

Deep Drawing, Embossing, Piercing and Flanging an Aluminium Shell

By JOHN WALLER

The component shown in Fig. 1 required a finish free from scratches, alignment between the sets of hole centres, and letters embossed in the lower cavity without irregular projections. Blanks 10 in. dia of 0·048 in. aluminium were supplied ready cut. The sequence of operations is indicated in Fig. 1. A double-action press was used, with an air operated cylinder to give firm control over the material and provide positive ejection.

The cut disc lies inside locating pins B equally spaced round die A which is fitted into a recess in bolster C, the heads of the pins being ground in position concentrically with the aperture.

Initial holding of the disc is by ring G which descends by action of the outer press slide just prior to the punch meeting the component. The ring is secured to top plate K and both are bored a sliding fit over punch H and J.

The punch nose is separate and hardened, ground and polished. A deep recess in the holder avoids long fixing screws. The screw holes in the ejector are lightly riveted over and made flush with the surface which contacts the shell.

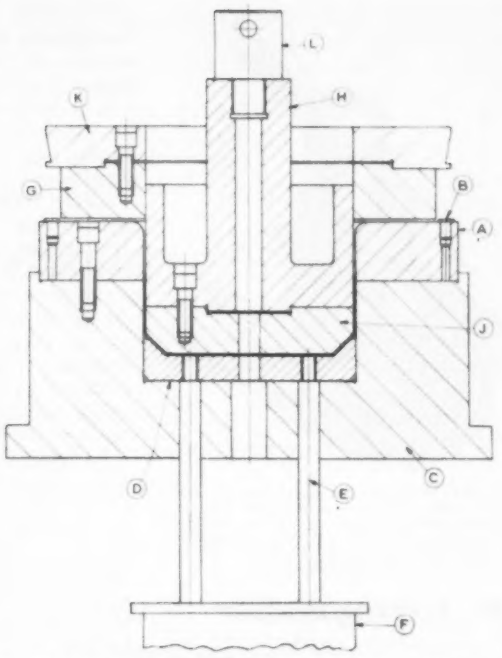


Fig. 2.—This tool makes approximately 40% of the total draw and imparts a 45° angle on the floor surface of the shell.

Fig. 3 illustrates the next drawing tool. A location for the shell is obtained from the angle formed in die A, and the part is held vertically and against this face by blank holder E. The punch causes the shell to slide down this angular surface into the cavity and to assume the shape depicted.

For the third and fourth draws shown at Fig. 1, D

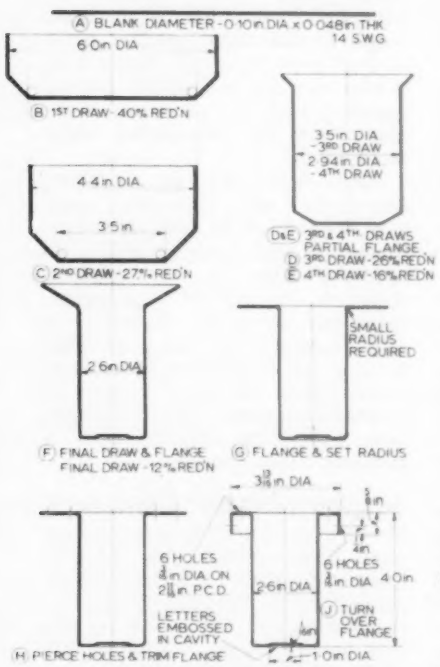

A BLANK DIAMETER - 0·10 in DIA x 0·048 in THK 14 S.W.G
6·0 in DIA
B 1ST DRAW - 40% RED'N
4·4 in DIA
3·5 in
C 2ND DRAW - 27½% RED'N
3·5 in DIA - 3RD DRAW
2·94 in DIA - 4TH DRAW
D & E 3RD & 4TH DRAWS PARTIAL FLANGE
D 3RD DRAW - 26% RED'N
E 4TH DRAW - 16% RED'N
2·6 in DIA
F FINAL DRAW & FLANGE
FINAL DRAW - 12½% RED'N
SMALL RADIUS REQUIRED
G FLANGE & SET RADIUS
3 12/16 in DIA
6 HOLES 3/8 in DIA ON 2 11/16 in P.C.D.
LETTERS EMBOSSED IN CAVITY
H PIERCE HOLES & TRIM FLANGE
2·6 in DIA
6 HOLES 3/8 in DIA
4·0 in
J TURN OVER FLANGE
1·0 in DIA

Fig. 1.—Workstages in converting a flat disc into finished shell

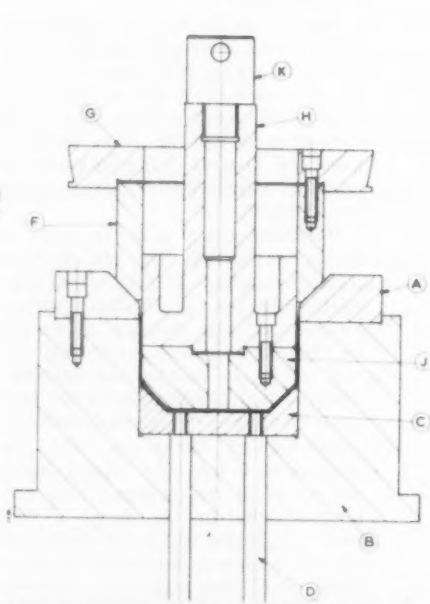


Fig. 3.—Except for the die this tool closely resembles that of Fig. 2. The blank holder has an angular surface for restraining the component

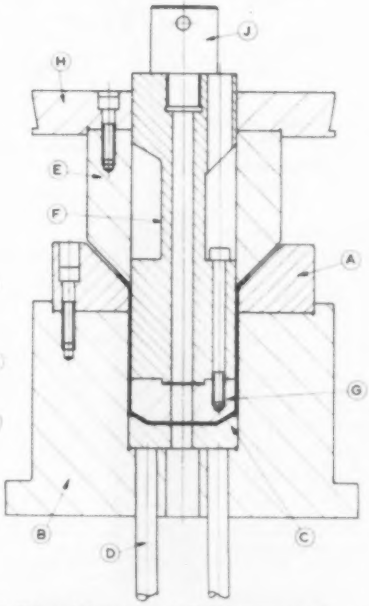


Fig. 4. This tool deepens the shell and commences to shape the flange. The component does not lose contact with the material

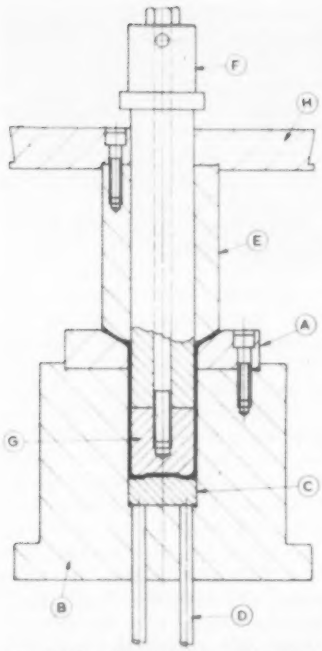


Fig. 5.—The flange is increased and the embossing of the recess is performed

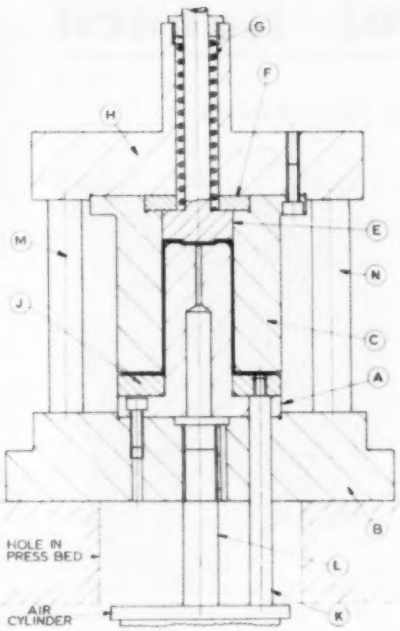


Fig. 6.—A single action tool for completing the flange and embossing the letters inside the recess

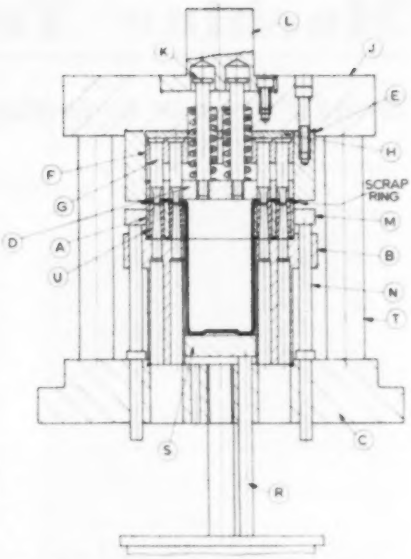


Fig. 7.—This piercing and trimming tool with positive ejection from both the upper and lower sections

and E are similar to the previous pressing, the tools are different in the construction of the punch and holder, and the shell is not pushed through the die but a portion still remains in contact with the angular surface, the flange on the component being thus commenced. Fig. 4 shows the details for both tools.

With the next tool, Fig. 5, in addition to a reduction in diameter, the flange assumes an angle of 30° and the embossing, incorporated in the ejector pad, is made as the ram makes the final bump at the bottom of the stroke. No letters are stamped at this stage.

The next operation is to set the flange and sharpen the radii. A single action press is employed and the shell is inverted as shown in Fig. 6, over the locating spigot and punch A. A hardened steel plate F behind die C is a precaution against damage to the iron bolster.

Flange trimming is incorporated with hole piercing by means of the tool shown in Fig. 7 which illustrates the tool in question and the location is taken from the outside diameter of the pressing by plate A which is bored to receive inserts U, the outside diameter being the cutting punch flange. A stripper plate M removes the ring of scrap, the same action of the air cylinder lifting the shell from the cavity. The pins operating the stripper are shortened to prevent them lifting until the last $\frac{1}{4}$ in. of movement of the cylinder. A small flange on pins N prevents them falling from mild steel raising block B.

The pressure plate D which slides inside die E is tapped for the screws K. The springs give this plate the pressure needed to eject a shell held to the punches. Inside the die are punch retaining plate and backing plate H. Pillars to locate the top and bottom halves of the tool are essential.

The final tool, Fig. 8, has location and punch A, pressure plate C, die D, and stripper plate cum pressure ring H. A point to note is the radius on die D. From 4 to 8 times the material thickness is necessary. A compromise of 6 times ($\frac{1}{4}$ in.) ensured the metal turning round the lower punch without difficulty.

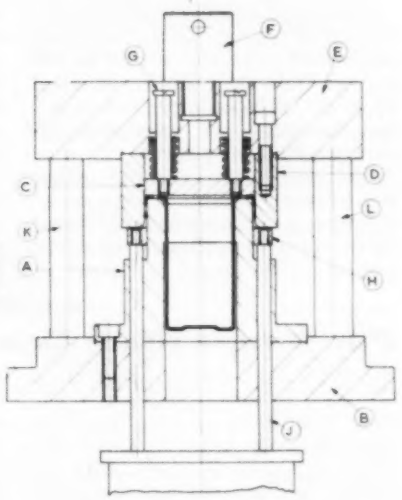


Fig. 8.—Turning over the flange is comparatively simple but it is important to secure ejection

The illustrations have purposely been simplified to show the details of each tool clearly—for instance, the pillars used for aligning the top and bottom members of the final piercing tool at Fig. 7 are shown at the rear instead of the usual corner-to-corner method which most designers prefer, and the bushes which slide on these pillars are omitted. The use of dowels for securing a detail radially in a tool or jig is well known, and these together with a variety of screws, are also not drawn. Air cylinders are standard items of equipment and how these are secured to the machine depends on the design and construction of the press on which the tool is used; hence only brief details are given. These tools are, however, interesting because they do record completely the method of converting a flat disc into a flanged shell with an array of holes and a deeply embossed recess in the bottom surface.

Machine Tool Record

Dual Purpose Grinding Machines

Sundstrand Arter Model 103 grinding machines are dual purpose machines which can be arranged for plain cylindrical or internal grinding by changing wheelheads. A machine can be purchased as either type and an additional wheelhead supplied at any time. Diameters and bores up to 3 in. can be ground. Maximum distance between external centres is 9½ in. and maximum depth of hole 4 in.

An ⅛ h.p. motor provides belt change workhead spindle speeds of 225, 475 and 600 rpm. The hollow spindle is in taper roller bearings and the nose is tapered for chucks, faceplates, etc. A draw-in collet of 1 in. dia capacity is available. The workhead can be swivelled 90° left and 45° right on an accurately calibrated base.

Sundstrand cylindrical and internal grinder

The table, on vee and flat ways, is traversed hydraulically or by hand, the former at speeds from 4 to 100 in./min. The table can be swivelled up to 10° included angle. A stop and dial indicator are available for accurate shoulder work.

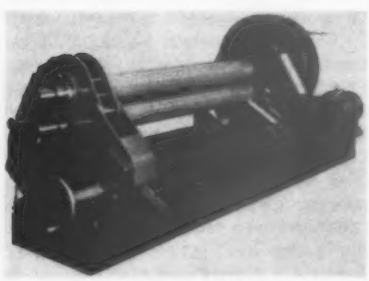
The wheelheads swivel 15° either side of centre and use a ¾ hp motor. V-pulleys provide speeds of 2320 and 2880 rpm. Wheelhead infeed is manual or automatic at either or both ends of table stroke—maximum 0·0005 in., minimum 0·0001 in. Table reversal is by trip dogs, micro switch and solenoid valve in less than ⅛ in. table movement, and positively and repeatedly within 0·005 in. on the workpiece.

Sole U.K. selling agents for Sundstrand Arter grinding machines are Rockwell Machine Tool Company Limited, Welsh Harp, Edgware Road, London, NW2.

Pinch-type Plate Bending Rolls

Recently the Bronx Engineering Company Limited, Lye, Stourbridge, have completed in their works a plate bending rolls of the initial pinch type, of a new design as shown in the photograph. The machine has top and bottom rolls driven, with the bottom roll adjustable *at an angle* for gripping the plate. This angular adjustment has certain advantages over the usual vertical adjustment, not only for gripping the plate but also when rolling plate. The side roll is adjustable at an angle in the usual way.

A complete range of these machines has been designed and a number of them has already been built. The example illustrated will pre-bend the edges of mild steel plates up to 6 ft wide and with a maximum thickness of ¼ in. Due to the arrangement of the bottom roll, the machine can be used for curving thicker plates, up to ⅜ in.



Bronx initial pinch type bending rolls

Fine Boring

The Stuart Davis fine boring machine Type FB.2 is electro-hydraulically operated to provide for a wide range of applications. It can be tooled for single purpose operations with automatic quick acting fixtures and multiple tooling, or may be equipped as a fully universal machine.

Standard operations include boring, facing, turning, chamfering, grooving, back facing with automatic tool retraction, either singly or in combination. Gaps in interrupted workpieces may be passed at rapid traverse rates, and boring may be accomplished in both directions of travel.

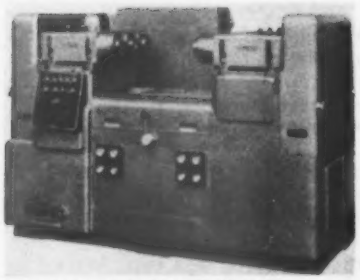
Constant feed rates are maintained regardless of variations in temperature and viscosity of the hydraulic oil. The controls are conveniently grouped within easy reach of the operating position. Cycle selection controls have been adequately simplified, thus making the machine ideally suitable for large or small batch productions.

The machine may be arranged with up to three individual boring heads on each bridge, or with a single multi-spindle head for boring series of holes to exact centre distances.

Work fixtures, whether operated pneumatically or hydraulically from the machine unit, may be suitably interconnected with the machine cycles. Provision is also made for fitting coolant as an optional extra item.

Adjustable cams or dogs, fitted to the work table engage plungers to control the various cycles. Two adjustable feed rates, in addition to rapid advance are provided, together with an adjustable duration of dwell at the end of the stroke. Feed to a positive dead stop ensures accuracy when boring to depth.

The feed rates selected are maintained constant regardless of variation of temperature and viscosity of the oil used in the hydraulic circuit. All controls are conveniently grouped within easy reach of the operating position. The cycle selections have been simplified, thus making the machine suited to large or small batch production. The automatic cycle may be controlled by moving the hydraulic throttle lever or direct from the push button control, and it may be interrupted at any point in the cycle. The throttle lever can also be used for slowing down or stopping the table anywhere during the working cycle. This feature is a great advantage when setting up. A brake is incorporated to bring the spindle rapidly to rest before the table reverse begins. This brake is electrically interlocked with the spindle motor to prevent starting of the motor while the brake is engaged. When using the cycle for boring on the forward stroke only, the table



Stuart Davis electro-hydraulic fine boring machine

cannot be reversed until the brake is stopped, and the spindle rotation stopped.

A feature is that the table ways are automatically pressure lubricated to ensure accurate and sensitive response to the controls at all times, the pressure being readily adjusted according to the weight of the combined fixture of work. The hydraulic control panel is housed in the front of the machine bed and uses the grooved manifold plate method to eliminate the necessity for numerous pipes and connexions and to ensure leakproof operation of the hydraulic system. The 1½ hp hydraulic pump runs at 1440 rpm to ensure smooth and constant speed of the component to the tool—Stuart Davis Limited, Much Park Street, Coventry.

Quintus Press

The Quintus high-force press which is to be made and marketed by the Swedish company Asea, consists of top and bottom yokes separated by two pillars, the whole being bound together on the outside by a winding of about 150 miles of high-strength steel wire under tension. The winding is done in a machine specially designed for the purpose and the tension is adjusted so that the stress is less for the outer than for the inner turns. The total compressive force exerted by the wire is slightly greater than the maximum hydraulic force exerted by the cylinders. The maximum working force is in the range 10 000—14 000 ton and the press including blocks weighs only from 14 to 30 ton.

Machine-swaged Hot Saws

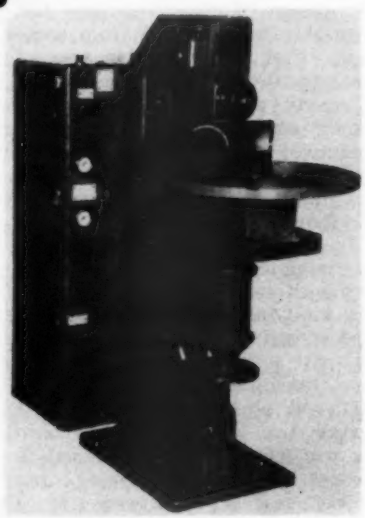
After more than two years' research and experiment, Edgar Allen & Co. Limited, Sheffield 9, have increased their range of hot saws by the introduction of the machine-swaged saw (for which patents are pending) in diameters from 24 in. to 84 in.

The saw has teeth thicker at the periphery than at the base, and the clearance enables air to be carried round with the saw, cooling the saw and overcoming binding.

The swaged saw has a much longer life, and requires less power to operate. The teeth can be re-sharpened and the saw can be re-swaged and teeth re-cut.

Tube Bend Marking

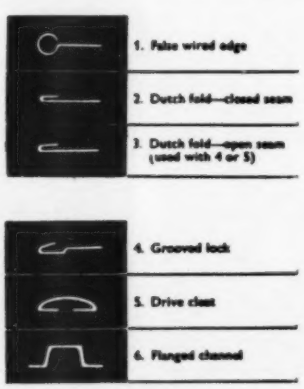
Edward Pryor & Son Limited, Broom Street, Sheffield, have recently designed a machine to mark indented lettering on seamless welding tube elbows such as are used in oil and petroleum refinery plants, within the range of 1½ in. to 8 in. nominal pipe size, both long and short radius, in angles 45°, 90° and 180°. The machine is powered by compressed air, but operated electrically from a single push button control. The elbows are placed upon a freely rotatable table, located and secured in position by an air clamping device (not shown in the photograph). The table assembly is mounted on a ram and raised under the marking roll by a 3 in. dia, controlled cylinder working through levers and a further cylinder causes the marking roll to make a part revolution. In operation, therefore, the workpiece, being trapped between the table and roll, is driven in a circular motion as the engraved lettering on the roll makes contact throughout its arc of movement. A two-position change over switch determines whether the roll makes a single or double (return) movement before the table lowers and releases the work. Marking time is as low as two seconds, but for a medium size of elbow, possibly 4 in. dia, a speed of twelve marked pieces per minute should easily be attainable.



Pryor machine for marking pipe elbows

Tools for Lock Forming

Lock-forming can now be undertaken with speed and economy by users of Pullmax universal sheet metal working machines. The new tools for this purpose are rapidly interchangeable on the P5, P9, T5 and U10 type machines and are designed to produce the 'dutch fold', 'grooved lock', 'drive cleat', 'flanged channel', and 'false wired edge'. The tools are intended for the working of straight edges on mild steel sheet up to 16 swg. While output ultimately depends upon the skill and experience of the operator, a speed of 6 ft to 10 ft per min is said to be easily attainable. Alfred Herbert Limited, Factored Division, Red Lane Works, Coventry.


1. False wired edge
2. Dutch fold—closed seam
3. Dutch fold—open seam (used with 4 or 5)
4. Grooved lock
5. Drive cleat
6. Flanged channel

Types of sheet edge fold produced on Pullmax sheet metal working machines

New Rubber Press Technique.—Boulton Paul Aircraft Limited, Wolverhampton, after nearly three years development work, are now operating their Suproform hydraulic rubber press to produce a wide range of metal pressings from tableware to motor car components. One new product will be an ornamental metal panel in stelvetite for the exterior decoration of buildings. The press employs a shaping die but the pressure applied to an elastic diaphragm with a large domed chamber comes from liquified rubber.

technique

—devoted to the discussion of practical problems
Readers are invited to contribute items from their own experience in matters relating to design, manufacture and maintenance

Casting Design for Foundry Economy

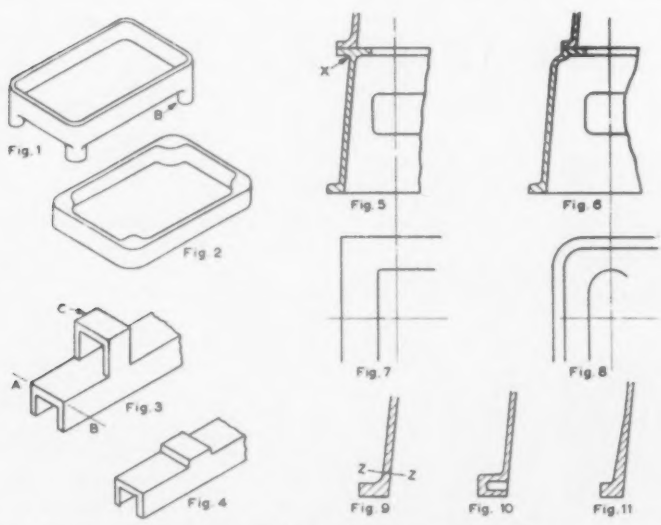
The design of any component can invariably be criticized from some angle. Particularly is this true of cast structures. The practice adopted by many progressive firms is to submit new designs to the works executive for consideration before the final design is decided upon. By this means considerable savings are effected in production costs.

To produce a casting speedily, the minimum of time should be employed in ramming the sand in the moulding box. The simplest type of casting is that in which the top part is flat and can be made in a shallow top box. When any details have to be cast in the top, a deeper box is necessary and also the top has to be strengthened to prevent the sand dropping out. In Fig. 1 is shown a tool tray, a number of which are placed at convenient height above each other on four pillars. Bosses to carry the holes for the pillars are shown at B. Incidentally, the joint of the mould is along the back, necessitating carrying the bosses in a top box. A simple modification as shown in Fig. 2 enables the job to be done in the bottom and thus reduces moulding time and costs.

Another case is shown in Fig. 3. In this instance the joint of the mould is along AB, and a deep top is needed to carry the portion C. As this was only a face on which another casting was bolted, it was modified to form a $\frac{1}{2}$ in. facing, as Fig. 4, and consequently was moulded in a much shorter time as a shallow top could be used. The only modification needed to the component to be fitted was to lengthen it by the amount that the other was reduced. The extra work involved in moulding a job in a three part box, when, with a slight modification a two part would suffice, is a waste of production time. Fig. 5 shows a part section of a machine base with an external flange X. This flange necessitates a joint in the mould to facilitate its withdrawal. The design in Fig. 6, however, is such that a straight draw can be made and no joint is required in the bottom. This slight alteration, while not detracting from the appearance of the finished machine, speeds up production. Not only can modification be made to speed moulding operations, but the risk of fracture, because of casting strains in many cast structures, can be removed by slight alterations.

Figs. 7 and 8 are plan views of the top faces of the castings shown in Figs 5 and 6, respectively. Fig. 7 shows a design, often encountered with the corners square, or only slightly rounded, as is also the case with the hole through the top. This type of casting has been known to crack when removed from the mould, or after several years service. In the latter case, the latent stresses gradually build up until a sudden shock or a load in excess of normal causes fracture. In Fig. 8 is shown a modified design with well rounded corners, and semi-circular ends to the top hole. Although a little costlier in pattern making, a superior article is produced in which the danger of fracture from casting stresses is much reduced.

Thick and thin sections of metal are often found in juxtaposition and are a cause of weakness, due to stresses set up during cooling in the mould. The judicious removal of redundant metal often strengthens a job more than the addition of extra material. Figs. 9 and 10 show alternative designs for the base of a forging machine. The example, Fig. 9, although heavier than Fig. 10, is not as strong and fracture is liable to occur at ZZ, at the juncture of the thick and thin sections. If, for any reason, the design shown in Fig. 10 is not suitable, an alternative is indicated in Fig. 11, which shows a strengthened form of Fig. 9, to which the change of section is gradual.—T. R. Harris.



Figs. 1—11.—Examples of modifications to casting design details which greatly simplified moulding and resulted in reduced costs and often removed the risk of unsoundness.

Metalock Repair of a Coining Machine

Recently a side frame of one of the coining presses at the Royal Mint developed a crack some 5 in. long. The fracture was repaired by the Metalock process, inserting a Masterlock at the back and front of the side frame and Metalock studs along the crack.

The normal Metalock method of repairing a casting fracture consists of peening into prepared apertures, at set centres, layers of Metalock keys. These keys are serrated strips of a ductile metal alloy, composed of nickel, steel and other constituents. The apertures into which they are inserted are made at right angles to the fracture and are identical

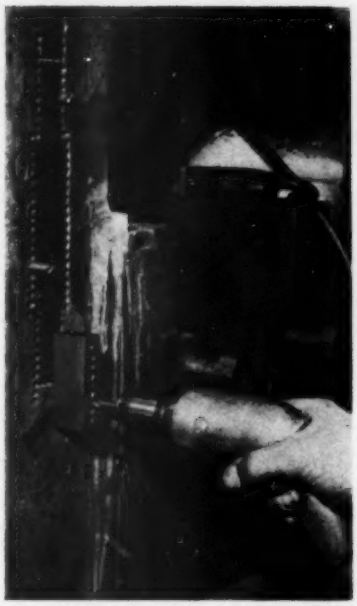
in shape and length to the keys. The depth of these apertures depends on the fracture. Several keys may be peened into a single aperture, depending on the thickness of the metal. Usually, apertures for keys are made into the fractured casting to a depth of three quarters that of the parent metal. Preparation consists of drilling a series of blind holes with the help of jigs across the line of the fracture. The holes are opened out and the metal between each hole is channelled out with a suitable tool so that a series of apertures across the line of the fracture is prepared.

Since they are highly ductile, the keys peen into a metal-to-metal condition and become almost integral with the metal of the object under repair. The high tensile strength of the keys ensures a return of a high percentage, if not 100% of the original lost strength.

The next stage is the drilling of holes along the line of the fracture, tapping them and the screwing in of studs. This is carried out progressively so that each stud bites into the stud already inserted next to it. This is the Metalace method which is complementary to the system of keys already described.

The insertion of a line of these interlaced studs along the fracture is of major importance. They restore rigidity to the casting through their shear value along the line of fracture and also through the shear value of the threads through the depth of the parent metal.

In this case, because of the nature of the fracture, the insertion of Metalock keys was not necessary. Studs sufficed.



Preparatory to the insertion of a Masterlock, the serrated Metalock holes are drilled with the aid of a jig

A Masterlock is a block of high tensile steel, rectangular in shape. Its edges are serrated in the form of half round holes. Like the Metalock key, it is inserted into a prepared aperture and, when in position, the surface is flush with that of the parent metal. Half holes in the parent metal match up with those in the Masterlock and the resulting full holes are filled with layers of short dowels, which are peened into position. The Masterlock is applied in areas of components where great stress is concentrated, such as the throat and side frame of the coining press at the Mint. The repair was completed in three days.

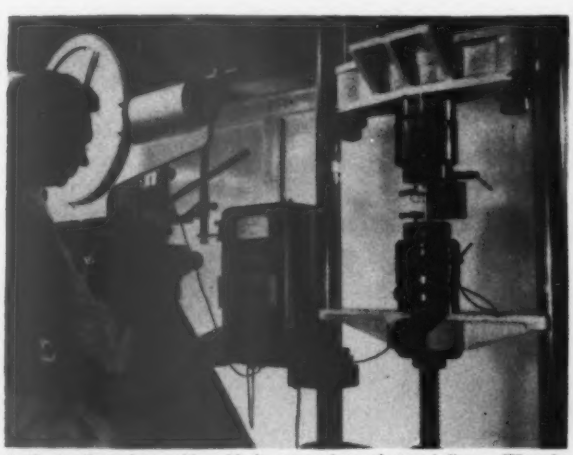
Automatic Proof Stress Indicator

A new instrument which automatically measures proof stress and does away with lengthy plotting of load/extension curves, may be fitted to any standard tensile testing machine and can be set to give direct readings of 0·05%, 0·1% or 0·2% proof stress as required.

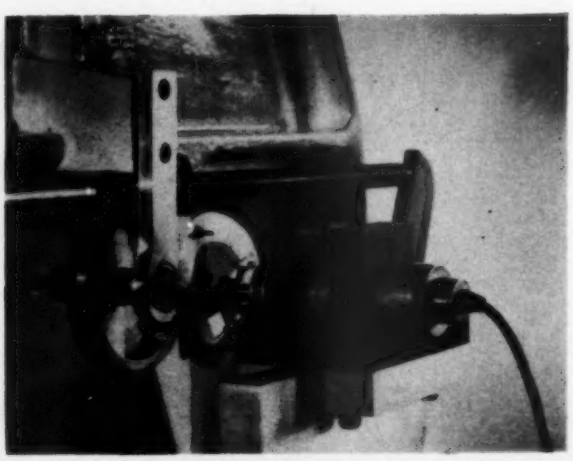
The working of the instrument is based on the electronic comparison of two signals, one generated by the load being imposed on the test-piece and the other by its extension. While increasing load is applied to the test-piece, the instrument indicates on the meter when these two signals cease to increase proportionally by a preset amount equivalent to the excess extension at the required percentage proof load.

Designed by Aluminium Laboratories Limited and built by Boulton Paul Aircraft Limited,the equipment consists of three units—an extension transducer, which is clamped on to the test-piece in place of the usual extensometer, a load transducer which is fixed behind the load indicator dial of the testing machine, and a compact unit housing the electronic gear, indicating meter and controls, which can be placed in any convenient position.

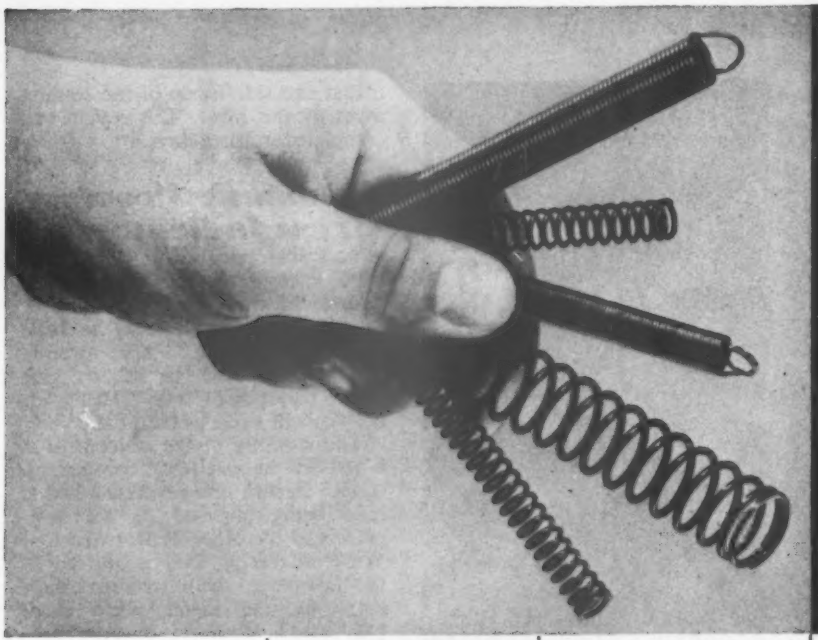
Although designed originally for testing aluminium specimens, this labour-saving piece of equipment can be used equally well with any metal.



Amsler tensile testing machine with the automatic proof stress indicator. When the needle points to zero the required percentage proof stress can be read off the test machine dial at top left. The extension transducer, which provides a signal proportional to extension, can be seen attached to the test-bar



Rear view showing the load transducer which provides a signal proportional to load. It is driven by the pointer shaft through a flexible coupling, and the rotary drive is converted to linear movement by means of a screw inside the transducer body



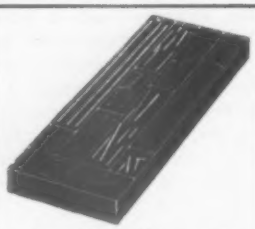
Let Terry's assorted springs help with your experiments

No. 1200. Three dozen Assorted Light Expansion Springs, suitable for carburettor control, etc. **15/-**

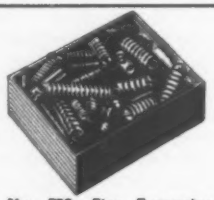
No. 757. Extra Light Compression, 1 gross Assorted, ½" to ⅞" diam., ½" to 2½" long, 27 to 19 S.W.G. **18/-**

No. 753. Three dozen Assorted Light Expansion ½" to ½" diam., 2" to 6" long, 22 to 18 S.W.G. **12/-**

No. 760. Three dozen Assorted Light Compression Springs. 1" to 4" long 22 to 18 S.W.G., ½" to ½" diam. **7/6**



No. 1217. One gross Assorted springs. **45/-**



No. 758. Fine Expansion Springs. 1 gross Assorted ½" to ½" diam., ½" to 2" long, 27 to 20 S.W.G. **18/-**

Pick the spring you want, when you want it, from our fine range of small Boxed Assortments of Experimental Springs. We can show you only a few from the range here. Send a postcard for our full list—and if ever you're stuck with a Spring problem our Research Department will be pleased to put their long experience at your disposal.

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Cut Production Costs with Terry's Wire CIRCLIPS. We can supply immediately from stock—from ½" to ½".

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HT93

In Brief . . . .

Notes on New Materials, Plant and Machinery

Lever taps.—Two redesigned lever taps for use with compressed air or liquids, with self-sealing seating and smooth exterior are announced by Alfred Bullows Limited, Walsall.

Contact Bi-metal.—Onlaid bi-metal made by Johnson, Matthey & Co. Limited, London EC1, has one or more strips of contact material standing proud of the backing material.

Electric Vibrator.—The new VS1 electric vibrator made by Sinex Engineering Company Limited, Feltham, is of small size and weighs 8½ lb. Centrifugal force output can be varied from 0 to 150 lb at 3000 rpm.

Vermiculite Refractory.—A vermiculite/ciment fondu insulation developed by Mandoval Limited in association with Welangrind Limited, London SW6, is used in the latter firm's new "Heatlock" all-electric 300 lb holding furnace.

Fighting Corrosion.—An important part of the Corrosion Engineering Service of BTR Industries Limited, London SW1, is the lining and covering of vessels, pipes, etc. with rubber and ebonite. A variety of grades and qualities caters for changing temperature, abrasion and shock.

Hydraulic Pack.—Chamberlain Industries Limited, London E10, are marketing a range of self-contained hydraulic power packs for supplying hydraulic machines, tools, etc.

pH Control.—English Electric Aviation Limited, in conjunction with W. G. Pye & Co. Limited, are utilizing the advantages of continuous pH measurement whilst carrying out large scale pilot plant trials on ceramic slip preparation, employing an industrial flow type pH electrode system installed in a by-pass feed line of a batch mixing unit.

Temperature Recorder.—A new Fielden temperature recorder is fully transistorized and servo operated and has a 15-in. indicating scale.

Container Leasing Plan.—The British Aluminium Company Limited in association with Mercantile Leasing Company Limited has devised a scheme for the rental of aluminium containers of all shapes and sizes.

Eye Protection.—Attractively styled protective spectacles for men and women have been introduced by Mine Safety Appliances Company Limited, Glasgow.

Carbide-tipped Punches.—A new "fusion-tip" process for securing carbide tips to punches has been introduced by F. J. Stokes Limited, London W5.

Dust Extraction.—A mobile dust collecting hood made by Dallow Lambert Limited, Leicester, is mounted on a travelling belt which forms the top of the main suction ducting.

6-ton Winch.—A new electrically driven 6-ton reversing haulage winch rated for hoisting either at a line speed of 300 ft/min or for precision inching in both forward and reverse has been introduced by Henry Sykes Limited, London SE1.

Friction Screw Press.—Paul Granby & Co. Limited, London SW1, have introduced into England a friction screw press made by Hasenclever of Dusseldorf which has a rating of 2800 ton and delivers fourteen 31½ blows per minute.

Gauge Comparator.—A self-contained portable instrument made by I. V. Pressure Controllers Limited, Isleworth can be used for checking both pneumatic and hydraulic pressure gauges.

Flaw Detector.—The Mark 2 ultrasonoscope has been replaced by a new instrument with fast time base speed and high trace brightness. It has a maximum depth in steel of 24 ft.

Cut-off attachment.—The versatility of the Wolf angle grinder is extended by a new cut-off attachment which forms it into a rigid bench machine for repetition work.

Disc Mixer.—The "Kadyzolver-100" high speed open disc mixer made by Baker Perkins Limited, Peterborough has capacity up to 200 gal and variable speed drive from 700 to 1750 rpm.

Adjustable Lamp.—A very neat adjustable desk or workshop bench lamp has been introduced by Simplus Limited, London WC1, It has 24-in. reach and Horstman rolling weight action.

Plan Printer.—The new Mercury Major plan printer of E. N. Mason & Sons Limited, Colchester, will produce over sixty 40 × 30 in. prints per hour.

Flame-resistant Hose.—A new hose developed by BTR Industries Limited for conveying oil has a polyvinyl chloride and glass matt fire proof covering.

Air-cooled Diesel.—A 4-cyl air cooled diesel engine, the HA4, developing 24 bhp at 1000 rpm to 48 bhp at 2000 rpm continuous rating is now available from R. A. Lister & Co. Limited, Dursley.

Precision Level.—The principle of the spirit level with the addition of a conducting liquid and three electrodes is used in the new Electro-level announced jointly by English Electric Aviation and G. V. Planner. It can be used whenever a spirit level would be advantageous, and offers increased precision and remote indication.

Welding Transformer.—The new EMH type G2 portable gun welding transformer made by Electro Mechan-Head Limited, Ettingshall, has a rating of 75 kVA at 50% duty cycle.

Control Valves.—A new series of a.c. solenoid operated air control valves introduced by Air Automation, Wolverhampton, will deliver air at full bore through ⅛ in. orifice.

Elevating Trolleys.—Farrow & Jackson Limited, London E1, have added a stillage model to their range of "Skyorlift" elevating trolleys.

Micro-switches.—A new series of basic switches with current ratings of 25 amp announced by Honeywell Controls Limited, Greenford, will handle inrush currents of 75 amp with no effect on accuracy, repeatability or precision.

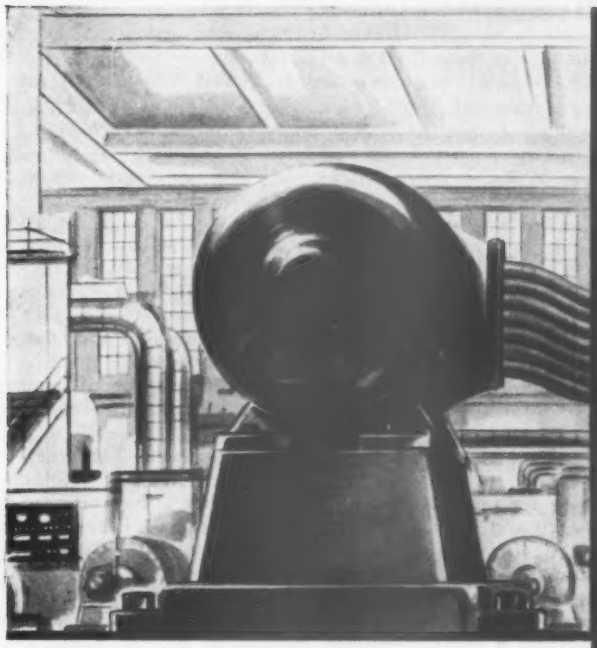
Paper Wipers.—"Kimwipes" disposable paper wipers supplied by Kimberley-Clarke Limited, Maidstone, are used in the precision assembly of servo valves by Dowty Fuel Systems.

Food Freezing.—Freezing is by air blast at −40°F in 56 ft long tunnels at the new Boreham factory of The Buxted Chicken Company Limited. The refrigeration equipment was supplied by York Shipley Limited, London NW2.

Steelworks Excavator.—An Eimco model 115 excavator is used by Dorman Long (Steel) Limited, Lackenby, for removing slag from furnace pockets.

Tight-radius Bends.—A machine which can make pipe bends as small as 1½ times the outside diameter of the tube is available from Chamberlain Industries Limited, London SW1.

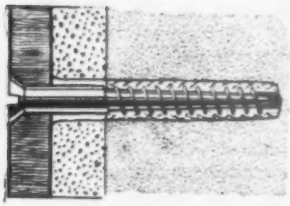
FASTENING HEAVY EQUIPMENT
FIXING LIGHT COMPONENTS



RAWLBOLTS

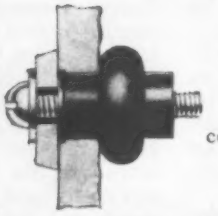
Where a bolt fixing is necessary or where extra heavy loads are involved Rawlbolts are the perfect fixing. They require no grouting, are instantly locked in the hole and enable machinery to be put into operation immediately. There are two types — loose bolt and bolt projecting to suit the nature of the job. Sizes are from ⅜" to 1" in various lengths.

RAWLPLUGS

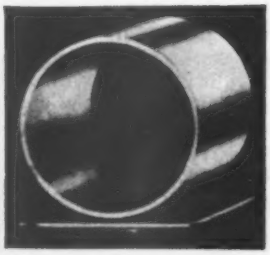


For screw fixings in solid materials Rawlplugs will take loads up to a million times their own weight. The tiny No. 3 (4") is used for fixing cable clips, the largest No. 30 (1") for fixing electrical and other gear to walls or floors will take direct loads up to four tons.

RAWLNUTS



In the range of Rawlplug Cavity Fixings the RAWLNUT has almost every advantage. It will make blind fixings in the thinnest of 'shell' materials, or in the larger sizes is suitable for hollow pot, or friable composition materials which will not hold conventional fixings. In situ it is vibration proof, waterproof, airtight, and insulative. It is extensively used in aircraft and car assemblies. There are sizes from ¼" BSW to 1" BSW and alternative threads.



The illustration here shows how it is possible to fix a metal plate to a tube. It is also possible to stop a leak in a tank.

RAWLPLUG

97184

THERE ARE 25 DIFFERENT TYPES OF

FIXING DEVICES FOR SPEED AND ENDURANCE

THE RAWLPLUG COMPANY LTD., CROMWELL ROAD, LONDON, SW7

THE WORLD'S LARGEST MANUFACTURERS OF FIXING DEVICES

Optimum Design of Mechanical Elements. By Ray C. Johnson, London, 1961; John Wiley & Sons Limited. 92/- net (by post 94/3). 535 pp. 6 × 9 in.

The author of this book is a staff engineer with International Business Machines Corporation, and in it he expounds an explicit method of design which takes into account practical limitations inherently unavoidable in real problems, and thereby eliminates any possibility of obtaining unreasonable and impractical designs. For instance, in a very simple example of a tray to hold a given quantity of liquid and which is to be manufactured in large quantities, the only significant factor is cost and the primary design equation is therefore made up of the various cost elements. In the case of a bar under tension the equation is an expression of its weight. In the more complex example of a coupling stud the equation is written for the total energy absorbed at the condition of maximum force and corresponding elongation. The methods and examples become more complicated and cover structural elements, gear sets, springs, bearings, cams, brakes, etc. Many specific examples are solved in detail and there are numerous exercises which are undoubtedly useful for the reader to test his appreciation of the argument, and the demonstration of the method leads to the introduction of a number of interesting topics necessary for an understanding of practical limitations.

The book has been written for graduate level which makes it acceptable as a text also to experienced designers who, however skilled and successful they may be with the intuitive method of design, will undoubtedly be interested in this new systemization of the design process.

Non-Euclidean Geometry. By Stefan Kulczycki. London, 1961; Pergamon Press Limited. 70/- net (by post 70/10). 208 pp. 5½ × 8½ in.

This book marks the centenary of the death of Lobatchevsky, who in 1830 published the first paper on non-Euclidean geometry, a work which was greeted with ridicule at the time and was never fully accepted during his lifetime. It is widely known now and the object of the present book (apart from the commemorative one just mentioned) is to give an exposition reasonably within the reach of readers equipped with no more (or very little more—some trigonometry is also required) than the formulations and arguments of elementary geometry. The important basis of the argument is the proof of the theory of parallelism using the Lobatchevskian conception of the horosphere, a surface consisting of all points symmetrical to a given point about a bundle of parallel lines all of which are considered to pass through an infinitely distant point which is the centre of the horosphere. In the further development of the theory the author takes in hyperbolic functions and some conceptions of spherical trigonometry and analytical geometry. The first, introductory part of the book is very interesting, in which is presented facets from the history of geometry from the earliest times, the surveyors of Egypt and the mathematicians of Babylon, and Plato, Aristotle and Euclid, to the modern creators of non-Euclidean geometry.

books

Hydraulic Fluids and Engineering Applications. By R. H. Warring London, 1961; The Trade & Technical Press Limited. 35/- net (by post 36/-) 109 pp. 7¼ × 9¾ in.

The performance of liquids conducted in pipes and tubes, and that level of fluid dynamics which is satisfactory for establishing engineering solutions—these notions together form the scheme and basis of this essentially practical book. It is not about hydrualic machinery, but about the working fluid—and what happens to the working fluid in a hydraulic system is demonstrative of the success or otherwise of the design and of the performance generally of the machinery. The first group of chapters deals with fluid parameters and mathematical solutions, and the second with the various fluids in use and their characteristics. The text has a generous accompaniment of tabular data and working design charts, the whole being a comprehensive compendium of information for practical use by the designer and for reference and as an aid to understanding to all who use hydraulic machinery.

Friction Materials for Engineers. Chapel-en-le-Frith, 1961; Ferodo Limited. £1. 60 pp. 8¼ × 11¾ in.

This is an authoritative work from the technical staff of a company famous for their friction materials. It discusses the various types of conventional friction linings and then examines fundamental design considerations including the assessment of drum temperatures, power ratings, self-servo factors and life values. Also dealt with are the calculation of friction material dimensions for brakes, clutches, metal mating surfaces for friction materials, sintered metal brake and clutch linings, and cermet friction materials. There are 29 tables of data, 62 line illustrations and detailed drawings, and twenty plates in the handsome and well produced book. A loose-leaf supplement contains data sheets relating to characteristics and applications. The book is available from any Ferodo office.

Twenty-one and a half Bishop Lane.—The latest company history published by Newman Neame, *Twenty-one and a half Bishop Lane*, marks the centenary of J. H. Fenner and Company Limited of Hull—makers of power transmission equipment. Its interest extends beyond friends and members of the firm to the general reader and the student, in the indications which it provides of much that is important in Britain's wider industrial history. In the words of the author, Ralph Davis, the company's history 'shows a firm swept along by and contributing to the gathering momentum of technical change; it shows the tenacity of an exporting concern at the mercy of world events; it shows the dramatic effect of American inventiveness on British business; above all it shows how men of resource and determination have helped to shape the economic history that appears in the books, and are still doing so'. The book takes its name from the address of the little workshop in the business centre of Hull where the first Joseph Henry Fenner, journeyman currier, started his business in 1861. Since then the company has grown into a prosperous group employing more than 30,000 people. In addition to the central factory at Marfleet,

For the convenience of readers—

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158 Temple Chambers, Temple Avenue, London, E.C.4

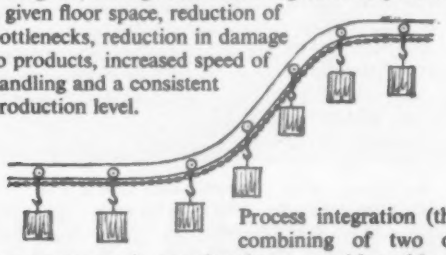
CUT HERE

Materials Handling-1

Materials handling may well be defined as the technology covering the movement and storage of everything in and about industrial or commercial premises. The term covers the handling of raw materials as well as tools; the movement of components between operations and in stores, of finished products, and of the scrap, cutting oils and process machinery; and the movement of workpeople in relation to the handling of material.

The object of a materials-handling survey is to eliminate handling as far as possible and to study the remaining operations to ascertain if they can be economically and efficiently mechanised, i.e., if mechanical handling can be applied.

Improved materials handling raises productivity, for it gives, among other benefits: greater output from a given floor space, reduction of bottlenecks, reduction in damage to products, increased speed of handling and a consistent production level.



Process integration (the combining of two or more processes in one situation or machine with no manual inter-process handling, or the mechanical linking together of two or more processes for automatic operation) is one of the preliminary steps in the development of automation. A stage is achieved quite close to automation when the processing and handling are completely integrated, for then instrumentation and control can be readily applied.

MECHANICAL HANDLING

Many kinds of mechanical-handling equipment are in use today, each with its own attributes and uses, but in most cases there is only one type which offers the best solution to any one handling problem. Most mechanical-handling equipment is electrically operated, and the judicious use of electricity in this way can substantially increase productivity, reduce production costs and improve conditions for the worker, for the expenditure of very little power.

Main Categories of Mechanical Handling Equipment

LIFTING EQUIPMENT; OVERHEAD RUNWAYS; CRANES; CONVEYORS AND ELEVATORS; INDUSTRIAL TRUCKS.

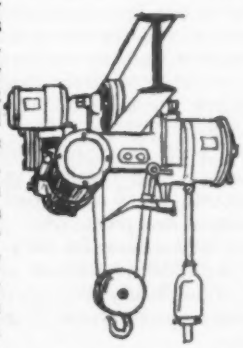
LIFTING EQUIPMENT

Electric pulley blocks are used for loading and unloading purposes, warehousing and in process work. When used with a trolley they have great flexibility. No manual effort is required, hence lifting does not cause any fatigue. They may use either chain or wire rope, and the speed of lift of both types is slower as the lifting capacity increases. An inching motor may be fitted to give a very slow speed for accurately positioning the load, for example in a jig.

Lifting magnets are used for the handling of iron and steel in conjunction with a crane or hoist. They do away with the necessity for slings and give increased speed of movement. They can lift castings, ingots and swarf, scrap, rolled steel sections, and can be used in loading bays, yards, machine shops, foundries and steelworks.

OVERHEAD RUNWAYS

Overhead runways have many uses where lifting and/or transport are required, when frequency of flow does not warrant a conveyor, e.g., for loading and unloading lorries, in core ovens, for feeding machines, for storage, for maintenance purposes, for textile drying and interconnecting two or more buildings. A runway consists of a steel girder along which a load trolley runs, and can incorporate switches, turntables, drop-sections and drop-arms and weigh-sections. Electrification of a runway takes all the manual effort out of the handling and movement, which can be completed more quickly. It consists of two main items: the electrified drive of the trolley (i.e., a power trolley) along the runway and an electrically operated lifting unit, usually an electric pulley block. A telpher has a cab for the operator suspended from trolleys on the runway and mechanically connected to the electrically driven trolley of the pulley blocks, thus travelling with them. Telphers are employed for handling individual loads which may be outside the range of normal electric blocks, e.g., when the highest speeds of travel or hoisting are required.



For further information, get in touch with your Electricity Board or write direct to the Electrical Development Association, 2 Savoy Hill, London, W.C.2. Telephone: TEMple Bar 9434.

Excellent reference books are available on electricity and productivity (8/6 each, or 9/- post free)—'Materials Handling in Industry' is an example.

E.D.A. also have available on free loan in the United Kingdom a series of films on the industrial uses of electricity including one on materials handling. Ask for a catalogue.

7923

re-built and vastly extended since the war, factories are now operating at Sutton Road, Hull, at Cleckheaton in the West Riding, in Lancashire at Accrington, Colne, Barrowford and Church, and overseas, in India at Madurai and Pallavaram (Madras), in Australia near Sydney, in South Africa at Johannesburg and in Germany at Ansbach.

B.I.S.F. Report.—In the annual report of the British Iron and Steel Federation (Steel House, Tothill Street, London SW1) the president, Sir Julian Pode, says that the industry recognizes that aggressive selling is the key to prosperity, particularly overseas. They are prepared to enter the Common Market with no more than transitional arrangements and to adopt the E.C.S.C. pricing system. A cautionary note is given as regards fuel. Britian, says Sir Julian, is becoming a high energy cost country in a low energy cost world—an adverse trend which must be halted if Britain is to compete in Europe.

Pneumatics Wallchart.—A wallchart size 30×20 in. in three colours, showing the principle and main components of a pneumatic system has been published by Educational Publications Limited, East Yardsley, Wakefield, Yorks., in collaboration with Lang Pneumatics Limited of Wolverhampton. The price of the chart is 1/- net.

"Heads and Threads".—A new edition of the handbook and buyers' guide of this title has been issued by the British Bolt, Nut, Screw and Rivet Federation (Joint Secretaries: Heathcote & Coleman, 69 Harborne Road, Edgbaston, Birmingham 15; and Peat, Marwick, Mitchell & Co., Queens Square, Middlesbrough). The directory of members shows clearly what each makes and there is a complete indexed list of specifications.

"British Engine" Technical Report.—Volume IV in the new series of reports issued by the British Engine Boiler & Electrical Insurance Company Limited, Longridge House, Manchester 4, is devoted to discussing some of the service failures investigated and also papers on the limitations of radiography in detecting crack-like defects in thick sections, and on the non-destructive testing techniques used by the company. The report, which contains 92 pages and is profusely illustrated, appears annually and costs 12/6.

Heat Bibliography, 1960.—The latest bibliography of books, papers and articles prepared by the Heat Division of the National Engineering Laboratory is now available from H.M. Stationery Office, price 25/- net. It is the seventh of the series and is a substantial, foolscap-sized volume of 317 pages of typescript. The entries appear in subject groups, arranged alphabetically under authors' names in each.

What is PR?—A small booklet which discusses the controversial subject of public relations is available free to business executives from Business Press Bureau Limited, 22 Wood's Mews, Park Lane, London W1. It presents the argument in a knowledgeable but light and readable style.

Factory Law.—To assist those who want to know what is in the Factories Act, 1961, which came into operation on April 1, the Ministry of Labour has published a new and revised edition of "The Factories Act, 1961; A Short Guide" (H.M. Stationery Office, 9d. net) which gives guidance about its requirements for the safety, health and welfare of workpeople, and the hours of work of women and young persons employed in factories.

Thermocouple Materials.—F. R. Caldwell, in National Bureau of Standards Monograph No. 40, (30 cents from the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C.) considers thermocouples used primarily as immersion temperature sensors from 0°C upwards. He gives the various properties of thermocouple materials including the newer noble metals and refractory metals for use in the extreme range.

The Engineer Buyers Guide.—The 1962 edition of The Engineer Buyers Guide is now available price 12/6 post free from 28 Essex Street, Strand, London WC2. In addition to a comprehensive indexed list of manufacturers of engineering products it contains useful general information on exhibitions, societies, national undertakings, etc.

Coal: The Price Structure.—A 1962 edition of the booklet of this title has been published by the Federation of British Industries, 21 Tothill Street, London SW1, price 3/6. An agreed procedure for calculating the prices of industrial coals based on the heat content with adjustments for other characteristics.

Applications of Finish Blanking.—A research report on this subject has been published by the Production Engineering Research Association, Melton Mowbray, Leics, price 7/6. It deals with the design, construction and use of finish blanking tools and gives particulars and illustrations of 27 examples.

Aid for Export.—A booklet entitled "World Wide Publicity Service" from the Central Office of Information, Hercules Road, Westminster, London SE1, sets out the official publicity services available to industrialists who are interested in opening up new markets. It gives the name and telephone extension of the contact for each service and lists the offices in the Regional Organization.

New Standards

Copper and Copper Alloys B.S. 2870, price 30/-. B.S. 2872, price 17/6.

The second and third schedules of wrought copper and copper alloys cover forging stock and forgings, and sheet, strip and foil. B.S. 2870 includes all the requirements from existing standards for rolled copper and copper alloy sheet, strip and foil, and also certain other alloys including copper-beryllium for which separate British Standards do not exist. It does not cover drawn strip, which will be included in another standard now being prepared.

B.S. 2872, the schedule for forging stock and forgings, is like the others in that it includes all requirements from existing standards. It covers 12 alloys and their requirements are split into four sections. It is again an attempt to co-ordinate requirements, and in particular to rationalize the specifications for high tensile brasses, and also to cover Services' requirements as far as possible.

To facilitate international discussions, 0·2% permanent set stress values have been included in addition to the usual 0·1 %.

PVC-covered conductors for overhead power lines (B.S. 3485:1962). Price 5/-.

Two thicknesses of covering have been standardized. The thinner, coloured black, is for voltages up to 250 V to earth, and the thicker, coloured green, is for voltages up to 6·6 kV to earth. Both are acceptable to the Post Office when erected in accordance with the appropriate P.O. Engineering Department Memorandum. The thinner covering is also suitable for low-voltage overhead service lines erected on insulators, but not for the lead-in from an overhead service into a building.

British Standards Institution, 2 Park Street, London W1.

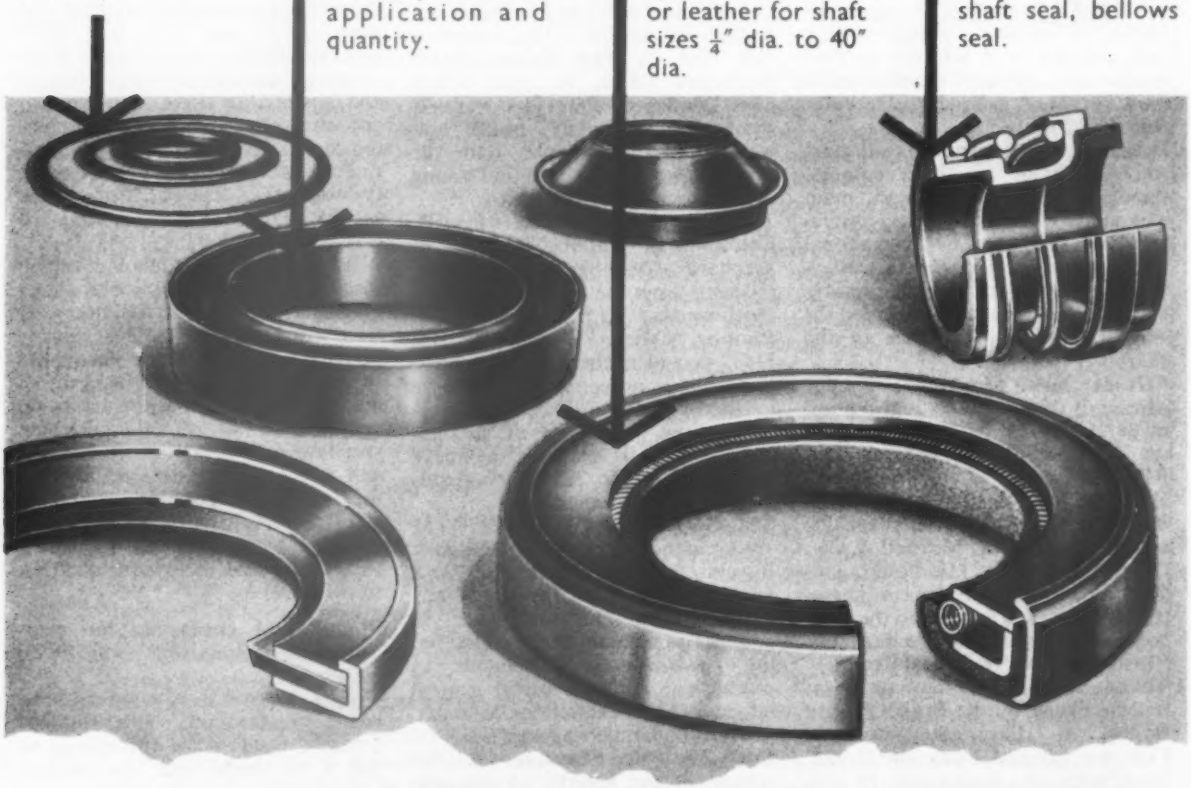
Throughout the world precision calls for Superfect * oil seals and hydraulic packings whatever the application or size required

'O' RINGS
'O' rings for static and reciprocating applications in two standard types ranging from $\frac{1}{8}$" i/d. to 24" i/d.

HYDRAULIC PACKINGS
"U", "V", and "Hat" packings, also square section washers in synthetic rubber. Sizes dependent on application and quantity.

ROTARY SHAFT SEALS
A comprehensive range of standard rotary shaft seals with sealing elements in synthetic rubber or leather for shaft sizes $\frac{1}{4}$" dia. to 40" dia.

ROMET SEALS
Designed primarily for rotary pumps, Romet Seals are in three types—diaphragm seal, single or double shaft seal, bellows seal.



SuPerfect Seals, "O" Rings and Hydraulic packings produced today are the result of 30 years' research and development of leather and synthetic rubber to meet the unending demands of the engineering industries to whom efficient sealing is an absolute necessity.

SUPERFECT

will solve your problem

SUPER OIL SEALS & GASKETS LTD
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BUSINESS & PROFESSIONAL

Personal

THE ROYAL SOCIETY PAUL INSTRUMENT Fund Committee has made a grant of £17,250 to **Dr. R. E. Richards, F.R.S.,** fellow of Lincoln College, Oxford and university demonstrator in chemistry, for the construction of apparatus to excite electron and nuclear resonances simultaneously in the same material operating at high field strength and with measurement of small line widths. The following have been elected Fellows of the Royal Society: **Sir William Richard Joseph Cook, Kt., C.B.** Member for Reactors, United Kingdom Atomic Energy Authority. **Professor Douglas William Holder,** Professor of Engineering Science in the University of Oxford. and **Dr. Stanley George Hooker, O.B.E.** Technical Director (Aero), Bristol Siddeley Engines Limited Bristol.

THE ADMIRALTY announce the appointment as Chief of the Royal Naval Scientific Service of **Dr. R. H. Purcell, C.B., Ph.D., F.R.I.C.,** the present Scientific Adviser to the Home Office. He succeeds **Dr. H. F. Willis, C.B., Ph.D., M.Sc.,** who is leaving the Admiralty to become a Scientific Adviser in the Ministry of Defence. **Rear Admiral R. S. Hawkins** has been appointed to be Chief Naval Engineering Officer in succession to **Vice-Admiral Sir Thomas Sandars, K.B.E., C.B.,**

CROSSLEY BROTHERS LIMITED announce the appointment of **Mr. S. H. Henshall, B.Sc.Tech.(Hon.), A.M.I.Mech.E., M.I.Mar.E., A.M.C.T.,** as Chief Engineer of the company. Mr. Henshall who has been with Crossley Brothers Limited, for 25 years was previously their chief development engineer.

Mr. J. K. Dean, M.A.M.E.M.E., has been appointed assistant manager, Northern Region, of the AEI Home District Office Division.

Mr. W. F. Potter, M.I.Prod.E., F.I.W.M., has been appointed deputy managing director of Rose, Downs and Thompson Limited of Hull, a member of the Davy-Ashmore Group.

Mr. John Coyte, until recently with The Elgar Machine Tool Company Limited, of Acton W3., has now joined the board of The Box Tool Company Limited, of Sapphire House, 18 Pentonville Road, London N1.

Mr. K. F. Hopkins has been appointed sales manager of the recently formed Process Control Division of R. B. Pullin & Co. Limited.

STOTHERT AND PITT LIMITED, engineers of Bath, announce that **Mr. T. E. R. Torrance,** chief engineer, and **Mr. P. T. Thomson-Walker,** London manager, have been appointed to the board of directors.

PARKINSON COWAN LIMITED announce that **Mr. George R. Barclay O.B.E.** has joined the company as a director. Mr. Barclay retains his appointment as chairman of Wild Barfield Limited.

DOWTY GROUP LIMITED announce that **Mr. A. W. Stanway** has been appointed a director of Dowty Electrics Limited.

Mr. P. G. Sargent has been appointed general industrial manager, Massey-Ferguson (United Kingdom) Limited.

BLAW KNOX LIMITED announce that **Mr. F. E. Varlow** has been appointed general sales manager and deputy to the managing director, of the Construction Machinery Division.

THE SIMMS MOTOR AND ELECTRONICS Limited announce the appointment of **Mr. S. C. Purkiss** to the post of assistant general manager of their associated company Coldpoint Drills Limited.

Mr. R. B. Ford, B.Sc., A.K.C., A.M.I.E.E., has been appointed chief engineer of Creed and Company, communications and data processing equipment manufacturers of Croydon, Surrey.

Mr. John Russell Taylor, T.D., B.Sc., M.I.Mech.E., M.I.E.E., technical consultant to Brookhirst Igranic Limited, a member of the Metal Industries Group, has retired. He joined Igranic Electric of Bedford in 1924.

Obituary

WE regret to record the death of **Mr. Robert Brooks, B.Sc., (Eng.), Hons., M.I.E.E.** formerly chief engineer of the Metropolitan-Vickers Control Department.

WE regret to record the death of **Mr. James Thomasson, B.Sc. Tech., A.M.I.E.E.,** who recently retired from the AEI Heavy Plant Division, Trafford Park.

WE regret to record the death of **Mr. William Sanderson Livsey. D.S.C. B.Sc. (Eng.), Lond., A,M.I.E.E.,** after a short illness. Mr. Livsey was in charge of land gas turbine sales for Associated Electrical Industries Limited.

WE regret to record the death of **Mr. Ronald K. Pridham** director of Monks and Crane Limited.

WE regret to record the death of **Mr. A. W. Berry,** director of the British Engineers Association since 1943.

WE regret to record the death of **Mr. Patrick Ernest Harry Wilde,** joint general manager of Darwins Group Limited.

WE regret to record the death of **Mr. Melbourne Dewhurst, M.Sc., M.I.E.E., M.R.I.,** of Dewhurst and Partner Limited.

WE regret to record the death of **Mr. John C. Learmonth,** the chairman and managing director of Andrew Whyte & Son Limited of Edinburgh.

Addresses

HYDRAULIC MACHINERY DRIVES LIMITED and Industrial Hydraulics Limited, members of the Keelavite Group have moved to larger premises in Reading. The new address for both companies is: 9 Arkwright Road, Reading, and the telephone number Reading 81369/60.

THE telephone number of Adrema Limited, and its Bradma subsidiary companies, Telford Way, East Acton, London W3, has been changed to SHEpherds Bush 5500.

ANTI-DUST SERVICES LIMITED have removed to Hayes Lane, Lye, Stourbridge, Worcs. (Telephone: Lye 2237/8. Telegrams: 'Takdust', Stourbridge).

NORVALL BROS. LIMITED, machine tool and electrical and mechanical engineers has been wound up and is now trading as Norvall Brothers. It has been taken over by Industrial Automation and Electronics Limited.

THE NIG MANUFACTURING COMPANY Limited have moved their offices and Works to Grove Park, The Hyde, London NW9.

CAMBRIDGE INSTRUMENT COMPANY LIMITED has moved its Manchester office (Mr. A. W. Burrell, resident engineer) to Lord Street, Manchester 3. Telephone: Deansgate 5391/2 Mr. K. W. Trevatt, resident engineer for S.W. Lancs., Cheshire, Derby and Flint, has moved to 12 Princess Building, 81 Dale Street, Liverpool 2. Telephone: Central 1980.

BARLOW-WHITNEY LIMITED announce that all departments have been moved from 2 Dorset Square, to Coombe Road, Neasden, London NW10. Telephone Nos.: DOLlis Hill 6616 (6 lines). Grams and Cables: Calidus London NW10.

S. N. BRIDGES & CO. LIMITED announce that the name of the company has been changed to Stanley-Bridges Limited and will, in future, be responsible for the sales of all Bridges and Stanley power tools.

THE export department of Ransomes and Rapier Limited is being moved from the company headquarters at Waterside Works, Ipswich, to the London Office at 32 Victoria Street SW1 (manager, Mr. E. W. H. Hadfield).

BRITISH INSULATED CALLENDER'S CABLES Limited have moved their N.W. regional headquarters and Manchester branch to Sherborne Street, Manchester 8. Telephones (unchanged) Blackfriars 3326; Deansgate 3760.

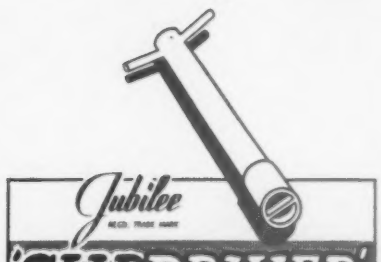
YESTERDAY, TO-DAY

AND TO-MORROW

GENUINE *Jubilee*
REGD. TRADE MARK

WORM DRIVE HOSE **CLIPS**

The Finest Clip in the World



Jubilee
'CLIPDRIVER'
REGD. TRADE MARK

COMPANION ACCESSORY TO THE WORLD'S FINEST CLIP

L. ROBINSON & CO. (GILLINGHAM) LTD., LONDON CHAMBERS, GILLINGHAM, KENT. TEL: 51182/3

SMALL *Batch* PRODUCTION

For small batch production, the B15 Mono Pump can be related to the desired capacity by varying the pump speed. At 1450 r.p.m., it will discharge at the rate of 50 G.P.H. at 40 lbs. per square inch or at 2850 r.p.m. the rate of discharge is 115 G.P.H. at 30 lbs. p.s.i.

Metal parts in contact with the liquid are Stainless Steel, it is compact, light in weight and it is economical in the use of power. It is self-priming, with a powerful suction lift of 25 feet and will handle both free flowing and viscous fluids.

The **MONO** pump

MONO PUMPS LIMITED
MONO HOUSE, 1 SEKFORDE ST., LONDON, E.C.1
Telephone: Clerkenwell 8911 Telegrams: Monopumps, London, Telex

and at Belfast, Birmingham, Bristol, Dublin, Durban, Glasgow, Johannesburg, Manchester, Melbourne, Newcastle, Wakefield.

MP287/L11109

FLUXITE LIMITED have moved to larger premises at Bridge Road, Merton Abbey, London SW19. Telephone: MITcham 9759.

Contracts and Work in Progress

ASSOCIATED ELECTRICAL INDUSTRIES *Traction Division*.—Order worth about £670,000 for eight 1200 h.p. diesel electric locomotives from the Nyasaland and Trans-Zambesia Railways. *Switchgear Division*. Three orders from Central Electricity Generating Board, Transmission Project Group for substation equipment to a value of approximately £750,000. *Cable Division*. Cabling contracts worth £336,000 from British Railways and C.E.G.B. *Motor & Control Gear Division*. £25,000 contract for electric motors and motor-generator sets for J. & E. Hall Limited. These are required for lifts to service buildings of the new Paternoster Development Scheme in the City of London.

ELECTRO-CHEMICAL ENGINEERING COMPANY Limited. (EFCO group of companies)—Supply of an EFCO-Udylite fully automatic plating machine for Hungary ordered through Nikex.

THOMAS SMITH AND SONS (RODLEY) Limited, manufacturers of cranes and excavators.—Three Smith "21" excavators ordered by Westminster Plant Limited, on behalf of Richard Costain Limited, for use on the construction of the El Cadillal Dam in Argentina.

GIRDLESTONE PUMPS LIMITED, Woodbridge, Suffolk. Order amounting to more than £16,000 from Saudi Arabia for centrifugal pumps for irrigation purposes.

U.S.RUBBER INTERNATIONAL (Great Britain) Limited and BTR Industries Limited. (in association with M. Golodetz of Mincing Lane.)—Supply of 22 miles of conveyor belting to the USSR. Shared between BTR and U.S. Rubber—the latter's portion will be manufactured by The North British Rubber Company of Edinburgh—this contract is the largest single order yet received from Russia for British-made conveyor belting.

STURTEVANT ENGINEERING COMPANY Limited.—Contract worth £800,000 from the Rumanian People's Republic for the supply and installation of plant and machinery for a new factory producing metallic hardware.

STRACHAN AND HENSHAW LIMITED.—A £67,000 contract for wagon marshalling equipment for Coalite and Chemical Products Limited of Chesterfield has been placed with the Bristol mechanical handling company.

BROOKHIRST IGRANIC (M.I. GROUP).—Supply of controls for three rolling mill drives for the Alcan Aluminium of Nigeria Limited plant at Port Harcourt. The mills are being manufactured by W. H. A. Robertson, under contract to Alcan of Canada, and the order for the controls, valued at £15,000 was placed by English Electric.

Supply of crane controls worth over £100,000 in connexion with development at the works of the Park Gate Iron and Steel Company Limited, near Rotherham.

Five hundred automatic, reversing, plug-in starters for textile loom drives for British Northrop of Blackburn. Another bulk order, from Hopkinsons Limited of Huddersfield, covers 50 heavy and 200 light duty automatic valve control units.

FAWCETT PRESTON AND COMPANY (M.I. Group).—Order worth nearly £150,000 from Polimex, the Polish state trading organization. This is the first sale of Fawcett extrusion machinery to Poland.

Business Developments

Company Acquisitions

WHITTAKER, HALL & CO. (1929) LIMITED, of Black Lane Engineering Works, Radcliffe, Nr. Manchester, have taken over the manufacture and business of the whole of the air compressor division of Burton-wood Engineering Company Limited. All enquiries for these compressors should be sent either to Whittaker, Hall & Co. Limited, at Radcliffe, or the PECO factory, Performance Equipment Company Limited, Sandford Street, Birkenhead.

THE FIRTH CLEVELAND GROUP have acquired the whole of the ordinary share capital of The Tyne Wire Rope Manufacturing Company Limited, of South Shields.

Trading Agreements

ASSOCIATED ELECTRICAL INDUSTRIES Limited has disposed of all its electrode and flux interests to Murex Welding Processes Limited.

UNDER a manufacturing and servicing licensing agreement with the Bijur Lubricating Corporation, U.S.A., Tecalemit (Engineering) Limited have extended their existing range of Tecalemit-Bijur automatic lubricating systems for use with oil. Tecalemit will also be holding service parts for American manufactured Bijur systems.

ARTHUR LYON & CO. (ENGINEERS) LIMITED, Park Works, Stamford, Lincs, have concluded a manufacturing arrangement with Barfords of Belton Limited, Grantham, Lincs., to produce a range of self priming, centrifugal pumps, entirely new in design and different in conception from Arthur Lyon's well known Alcon range.

HAMWORTHY ENGINEERING LIMITED, announce that trading will be carried on by three separate wholly-owned subsidiary companies, Hamworthy Pumps and Compressors Limited, Hamworthy Oil Burning Limited, and Hamworthy Hydraulics Limited. Hamworthy Engineering Limited will cease to trade and will remain as the parent company.

WILD-BARFIELD ELECTRIC FURNACES Limited have transferred the whole of their trading activities to a new company Wild Barfield Limited who have taken over all trading assets and liabilities and who will execute all current contracts. Correspondence should now be addressed to Wild Barfield Limited, Elecfurn Works, Otterspool Way, Watford By-Pass, Watford, Herts.—telephone Watford 26091.

UNDER a licensing agreement with the Chain Belt Company of Milwaukee, Wisconsin, U.S.A., Vokes Limited of Henley Park, Guildford, Surrey, will shortly begin production of the complete range of REX processing equipment for industrial wastes.

THE UNITED STEEL COMPANIES LIMITED, Sheffield 10, announce that an agreement has been made with Combustion Engineering Inc., of Windsor, Connecticut, for them to take over exclusive manufacture in the United States of Esshete 1250, a newly developed high temperature steel for use in steam power plants.

A NEW company has been formed, to be known as Firth Cleveland Laing International Limited in connexion with the world-wide licensing plans of the Firth Cleveland Group for exploiting the Laing tangential fan.

Agents and Distributors

ELGAR MACHINE TOOL COMPANY LIMITED have been appointed sole United Kingdom distributors of the "Cycle-matic" automatic expandable polystyrene moulding machines manufactured by Springfield Cast Products Inc., Springfield, Mass., U.S.A.

Aero Electrical Equipment

AEI Motor and Control Gear Division plan to devote the entire floor space of the company's aero equipment factory at Coventry to the manufacture of electrical equipment for aircraft.

Some of the floor space is now used for the manufacture of certain types of fractional horsepower motors for industrial and commercial purposes, and it is intended that in future these will be made at the AEI factory at Larne in Northern Ireland.

Wicksteed Increase Production

RECENT extensions with new machinery at the Kettering Works of Charles Wicksteed & Co. Limited, will increase production by around 50% and the delivery of all Wicksteed machines is expected to be improved from now on. The technical service department has also been enlarged and is available for trial cuts on special metals.

This specialised truck has a tilting platform which can be angled until flush with the floor. The load is drawn on to the platform by the Yale Pul-Lift anchored at the front end of the truck.

take time off WITH A YALE PLANT HANDLING TRUCK

One man and a Yale plant handling truck can shift machinery weighing up to 5 tons in a fraction of the time taken by more conventional methods. These rugged, versatile trucks come in capacities of 2, 3 and 5 tons. Write for illustrated brochure giving full details.

YALE
REGISTERED TRADE MARK

World's largest range of materials handling equipment

The Yale & Towne Manufacturing Co., British Materials Handling Division Dept. MW5, Wednesfield, Staffs. Phone: Willenhall 65511 Telex 33173

FLEXIBLE BELT LACING

A reliable safe joint easily fixed with a hammer.

All types of machinery belting can use 'BAT' Flexible Belt Lacing for joints of exceptional strength and flexibility held by the newly designed double rocker pins.

HEAVY DRIVE

CONVEYOR & ELEVATOR BELT FASTENERS

A strong, smooth butt joint which allows the belt to trough naturally. Withstands friction and abrasion.

MANUFACTURERS OF CARDED BELT HOOKS CONVEYOR FASTENERS LIGHT METAL PRESSINGS

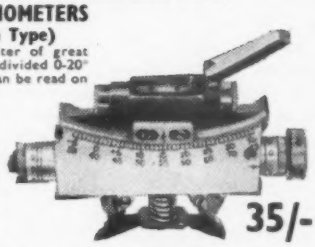
AUTOMATIC PRESSINGS LIMITED

Bat Works, Blackheath, Birmingham, England

ANY ITEM SUBMITTED ON APPROVAL— *WITHOUT OBLIGATION*

TOOLROOM CLINOMETERS
(Micrometer Bubble Type)

An Engineer's Clinometer of great precision. Main scale is divided 0-20° in 1° divisions. Angles can be read on the micrometer thimble to within 5 minutes, or by interpolation to within 1 minute. For their original military purpose a clip was fitted to the base but this clip can be easily removed in the Machine Shop. Nett weight 22 ozs. Length of base 3¼ in.



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GERMAN DRAWING INSTRUMENT SETS Brand new in velvet lined case. **£2.19.6**

OPTICAL EXPERIMENTAL SET in Transparent Pack. Type A contains 30 graded lenses. Type B contains 30 selected lenses, prisms and polaroids. Either type, per set. **42/-**

The *NEW* RUSSIAN MICROSCOPE as shown at the Soviet Trade Fair. **£47.10.0**

GBL 516 16 m.m. SOUND PROJECTORS—perfect **£59.10.0**

EX-R.A.F. ADJUSTABLE BENCH LAMPS **33/6**

EX-R.A.F. ILLUMINATED MAGNIFIERS with 3 in. Dia. lens. **38/6**

TRACING PAPER—EX-GOVT., 33 yds. × 20 in. Perfect. Per roll, including post. **21/-**

MINISTRY of AVIATION NAVIGATIONAL WRIST-WATCHES. World's greatest makes including OMEGA, INTERNATIONAL and CYMA. Perfect and fully guaranteed. Free approval without obligation. Fraction of cost. **£12.18.6**

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Phone: BELL 2106/7 Grams: BINOCAM Glasgow
Established 1907

Britain's greatest stocks of new, used and Ex-Government Optical and Scientific Equipment. Send for Illustrated Catalogue.

Steam, Oil and Water Fittings etc..

A handy and up-to-date work of reference for all who use steam fittings, tubes, packings and jointings, valves, cocks, lubricators, hoses and accessories, pipe coverings and all the other requirements of the maintenance engineer, appears in the form of a new catalogue issued by W. H. Willcox & Co. Limited, Southwark House, Southwark Street, London SE1. It is a well printed, profusely illustrated and strongly bound book which will withstand constant handling, Useful reference tables of flanges, screw threads, equivalents etc., are included.

Westinghouse Pneumatics

A complete range of pneumatic equipment is described in a new illustrated catalogue (Publication P3, "Pneumatics by Westinghouse") issued by Westinghouse Brake and Signal Company Limited, Hanham Road, Kingswood, Bristol. Included are devices for control, positioning and auxiliary purposes together with compressors and supply fittings. Some examples of recent installations illustrated in the booklet are an animal food mill, railway stock, earth moving plant, ships, textile machinery, road sweepers and atomic power stations.

Sliding Head Automatic

A brochure from Dowding & Doll Limited, 346 Kensington High Street, London W14, describes the new Dowding sliding head automatic and also examples of the work it does.

Screw Pitch Gauge

A gauge which is a combination of Whitworth and Unified screw forms is the subject of a new leaflet from Moore & Wright (Sheffield) Limited, Handsworth Road, Sheffield.

Electronic Die Saver

A folder from Radiovisor Parent Limited, High Path, London SW19, describes a device which prevents damage to dies by continually monitoring press operations.

Automatic Guillotines

Guillotines which will keep on cutting pre-set lengths of material unattended are illustrated in a folder from Wallis Engineering Company Limited, 399 Warwick Road, Birmingham 11.

Centre Lathes

The new Startrite-Orn Swedish centre lathes which have been recently introduced into the U.K. by Startrite Machine Tool Company Limited, Star Mill Lane, Chatham, are fully illustrated in a folder available from the company.

Valve Grinding Machine

A universal Swiss tool production machine for grinding the conical surfaces of poppet valves is dealt with in a new catalogue available from Haesler Sales, 4 Grange Street, St. Albans.

Unit Tooling

Components of unrestricted width can be pierced with a new range of unit tools described in a leaflet issued by Redman Tools & Products Limited, Gregory's Bank, Worcester.

Grinding Machines

A catalogue of Belgian Brumeca external high precision grinding machines comes from Gaston E. Marbaix Limited, Vicarage Crescent, London SW1.

Surface Finish Control

A new illustrated booklet describing surface finish characteristics and the use of Brush Surfinders is available from Brush Instruments, 37th and Perkins, Cleveland 14, Ohio, U.S.A.

Trade Literature

Readers interested in any of the catalogues reviewed here can obtain copies by mentioning* MECHANICAL WORLD *when writing to the firms concerned.

Diamond Insert Tools

A leaflet from Kennametal (Great Britain) Limited, 82-84 Coleshill Street, Birmingham 4, gives particulars of further additions to the range of Kendex Style KDG tools using "throw away" inserts.

Servo Recorder

Evershed & Vignoles Limited, Acton Lane, London W4, send a catalogue describing a new transistorized servo recorder which is accurate and has a remarkably quick response.

Hydraulic Copy Milling

A folder from The Hepworth Iron Company (Engineering) Limited, Hazlehead Sheffield, describes hydraulic copying equipment for quill control of vertical milling machines specially for accurate reproduction of complex three-dimensional shapes such as models and dies.

Instrument Switch

A leaflet from W. G. Pye & Co. Limited, P.O. Box 60, Cambridge, describes a new switch for precision resistance measuring equipment and potentiometers.

Lamp Shock Absorber.

A leaflet from J. E. Wildbore Limited, Peter Street, Oldham, Lancs., describes the Protectafil shock absorber which is claimed to treble lamp life by damping out vibrations.

Surface Heater

A new flexible surface heater capable of 450° C in glass cloth construction and 1000° C in quartz cloth is the subject of a leaflet from Electrothermal Engineering Limited, 270 Neville Road, London E7.

Recording Instruments

New catalogue sheets from George Kent Limited, Luton, list a 36-range recorder, new thermocouples, the Sinter-Strand temperature recorder, a thermocouple for stove-dome temperature measurement, instruments for furnace pressure control, and the Mark 3 Multelec electronic temperature and millivolt instruments.

Automation Systems

An illustrated bulletin describing the Bailey-700 computing, control and information systems is available from Bailey Meter Company, 1050 Ivanhoe Road, Cleveland 10, Ohio, U.S.A.

Circlip Pliers

A variety of special pliers for handling circlips are listed in an illustrated leaflet from J. W. Pickavant & Co. Limited, Bow Street, Birmingham 1.,

Variable Speed Motor

A new catalogue from Mawdsley's Limited, Dursley, Glos., describes the Mawdsley Mensforth Varianim infinitely variable speed a.c. motor which is now in full production.

Selenium Rectifiers

The Westinghouse H-series of lightweight selenium rectifiers are the subject of a new catalogue issued by Westinghouse Brake and Signal Company Limited, 82 York Way, King's Cross, London N1. The elements have an improved back contact and a crystal aligned selenium layer resulting in a non-ageing rectifier capable of operating at increased current density and element temperature.

Dry Bearings

Numerous uses of Glacier DU and DQ dry bearings are illustrated in a folder issued by The Glacier Metal Company Limited, Alperton, Wembley, Middlesex. The text is in English, Spanish and Portuguese.

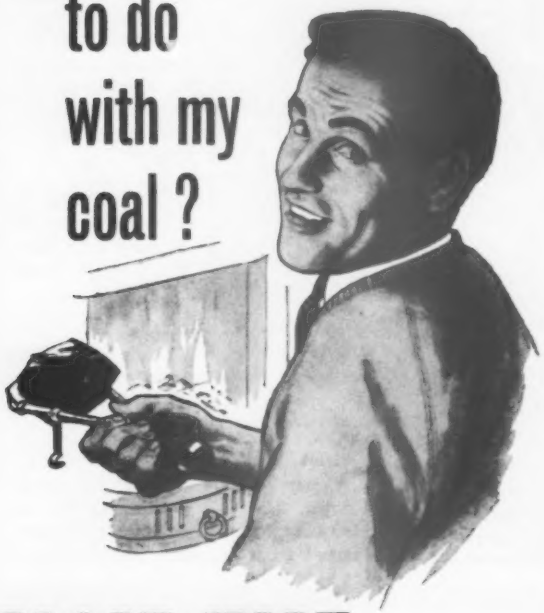
Air-cooled Diesels

Two new catalogues from R. A. Lister & Co. Limited Dursley, Glos., give details of hydraulic power mountings for Lister air cooled diesel engines, and particulars of installations of Lister air-cooled diesels in several makes of dumpers.

Concrete Batching Plant

The low-level and high-level concrete batching plants made by the Materials Handling Division of Thos. W. Ward Limited, Sheffield, are described in a new illustrated folder. Both plants are designed for one man operation and both can be converted to ready-mixed plants by the addition of further components.

...and what has BLACK-MOLY to do with my coal?



BLACK-MOLY

Coal cutters more than most machinery go through a tough time. The Black-Moly dry bonding process used on the moving parts of the main drive has meant fewer stoppages due to rust, seizure, and corrosion caused by dampness and dust. Only Miller's have the facilities to carry out this dry bonding on a big scale (parts up to 10 cwts.)

Thanks to Black-Moly your coal is cut quicker.

This is only one of the many, many problems outside the range of normal oils and greases, which Black-Moly is capable of overcoming. In fact, more than 50 special grades of Black-Moly are available to the industry. Post the coupon below; if we do not have a lubricant to meet your requirements we shall be pleased to advise against specific enquiries.

Molybdenum Disulphide, the base for Black-Moly, is a rare mineral which when suspended in oil, in a micronated mineral form, is the finest lubricant known.

To: JOHN MILLER & SON LTD · BRIGHOUSE · YORKSHIRE

*WITHOUT OBLIGATION send me further details of BLACK-MOLY Molybdenised Lubricants. Ask your representative to arrange an appointment.**

Name _____

Company _____

Address _____

_____ Telephone _____

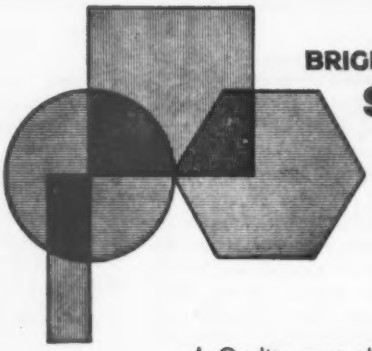
Position in Firm _____

M.W. 5.62 **Delete as required.*

BLACK-MOLY is the TRADE MARK of...

JOHN W. MILLER & SON LTD

Brighouse Yorkshire England Tel: Brighouse 1047 (3 lines)



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CARBON
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GROUND

★ Quality controlled throughout all stages of manufacture.

★ Large stocks covering a comprehensive range ensure first class service.

★ Our name is your guarantee of satisfaction.

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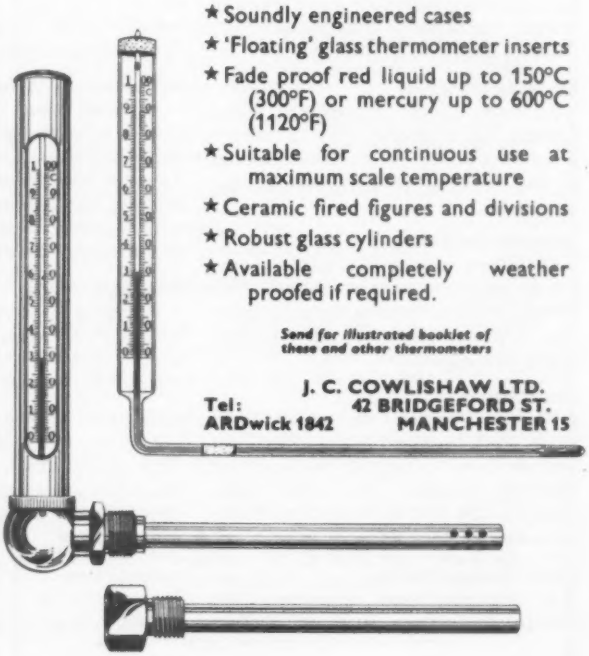

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Blaydon (Co. Durham). Churchill Gear Machines, Limited. The contractors for the erection of an office block are Thomas Clements and Son, Jesmond, Newcastle-on-Tyne. The architect is J. M. Angus, 3 Gallowgate, Newcastle-on-Tyne.

Northern Tubular Buildings Limited, The Close, Newcastle-on-Tyne. A factory and offices are proposed at Chain Bridge Road. The architects are Wetherell, Lamb and Partners, 24 Picton Place, Newcastle-on-Tyne.

Chester-le-Street. F. Reid, Ferens and Company Limited, electrical contractors, Orchard Street, Newcastle-on-Tyne propose workshop, stores and offices at Station Road, Chester-le-Street. Plans are being prepared by Fannell and Baddiley, Bridge End Chambers, Chester-le-Street.

Limmer and Trinidad Lake Asphalt Company Limited. Plans are being considered for the erection of a plant, with offices, canteen, and substation at Fatfield. The architects are Mauchlen, Weightman and Elphick, 12 Saville Row, Newcastle-on-Tyne.

Durham. Industrial Estates Management Corporation, Team Valley, Gateshead. A factory of about 25,000 sq. ft. is planned on the Dragonville industrial estate. Plans are being prepared by G. H. Gray and Partner, 8 Portland Terrace, Newcastle-on-Tyne.

Gateshead. Durham Divisional Coal Board, Team Valley trading estate, Gateshead, are to erect a large building to house an electronics centre.

Hartlepool. The Steetley Magnesite Company Limited, Hartlepool are negotiating for the purchase of 4·6 acres of land for proposed works additions.

Hebburn-on-Tyne. Hawthorn Leslie and Company (Shipbuilders), Limited, Hebburn. Outline plans have been approved for the construction of new shipbuilding berths and crane gantry.

The Bushing Company are to erect a factory at Whinney Lane, to plans by Cackett, Burns Dick and McKellar, 21 Ellison Place, Newcastle-on-Tyne.

Kendal. Post Office engineering centre at motor transport workshops at Kendal. The tender of John Twiname, Limited, Brigham, Cumberland, has been accepted.

Newcastle-on-Tyne. Tynecraft Industries Limited. Alterations and additions are proposed at Wincomblee Road. The architects are J. W. Taylor and Son, Gallowgate, Newcastle.

Peterlee (Co. Durham). Alexandre Limited, clothing manufacturers. The tender of Randle and Company, Back Dunelm, Sunderland, has been accepted for factory additions.

Stockton-on-Tees. British Titan Products Limited, Billingham-on-Tees propose laboratory at Ross Road Stockton.

Tynemouth. Gibson Readymixed Concrete Limited, Gosforth, are to erect a concrete batching plant at Motor Road, Albert Edward Dock, North Shields.

Acton. London Iron & Wire Works. A new factory is to be built between Bollo Lane and Stirling Road.

Ballywater, Co. Down. Mid-Ards Clothing Company Limited. The Ministry of Commerce, Belfast is to erect a new factory.

Bath. Horstmann Gear Company Limited, 93 Newbridge Road have applied for permission to erect premises at Brassmill Lane.

C.I.C. Engineering Limited, Street, have applied for permission to erect a new factory at Rush Hill.

Bognor Regis. Barlow and Parker Limited, New factory. New factories also for Lincass Electric Limited, and Royal Worcester Industrial Ceramics Limited.

Brighton. C. B. R. Jersey Mills, Shanklin Road, are to erect a new factory off Melborne Street.

Bromyard, (Herefordshire). Industrial and Tractor Services (Worcester) Limited, Carden Street, Worcester and Amourella Fashion Wear, Milverton, Taunton. Permission has been granted for the erection of new factories.

Camberley. Johnsons Wax Company Limited. Extensions are to be made to the factory at Frimley.

Chesterfield. Birtley Engineering Limited, are to extend their factory at Barker Lane.

Dartford. Amalgamated Oxides (1939) Limited, propose to extend their factory at Victoria Road.

New Factories

Doncaster. R. O. Arnold Limited, Wheatley Hall Road are to erect a new factory on Neale Road allotments site.

Dumbarton. The British Oxygen Company Limited, are to erect a new factory at Strathleven industrial estate. Wylie, Shanks and Partners, 12 Clairmont Gardens, Glasgow are the architects.

Dundee. Veeder-Root Limited, Kilspindie Road. Extensions are to be made to the factory.

Eastbourne. Dickeson and French Limited, 6 Grange Road are to erect a new factory at Brampton Road trading estate.

Edmonton. Viron Limited, 26 First Avenue, London N18. A new factory is to be built at Goodwin Road.

F. F. L. Sheet Metal Works, 17 First Avenue, London, N18 are to erect a new factory.

Falkirk. The Grahamston Iron Company Limited are to extend their works at Govan Avenue.

Glasgow. Philcote Manufacturing Company Limited, Edinburgh Road. Extensions are to be made to the factory.

The Imperial Tobacco Company Limited are to extend their factory at Alexandra Parade.

Grangemouth. Marbon Chemical Division of Borg-Warner Corporation of America. Plans have been approved for the erection of a new factory.

Greenwich. Diploma Cleaners, Anchor Street, London. S.E. have submitted plans for the erection of a new factory.

Grantham. Vacu-Lug Traction Tyres Limited. Plans have been approved for extensions to the factory at Gonerby Hill Foot.

Hereford. British Canners Limited. Plans for extensions to the factory at Bewell Street have been prepared by R. J. A. Wilson and McMillan, 15 King Street.

High Wycombe. Thurlow, Lucas & Janes, 86 Easton Street are the architects for extensions to the factory of D. Searle & Co. Limited.

Hull. Smith and Nephew Limited, Neptune Street. Extensions are to be made to the works.

Multiprint Limited, 71a Salisbury Street. Works extension.

Inverness. Partridge, Wilson Limited, Davenset Works, Evington Valley Road, Leicester. A new factory is to be erected.

Leeds. Jagger & Co. (Leeds) Limited, Goodman Street Cabinet Works, Hunslet are to erect a new factory at Forster Street.

Techno Commercial Limited, Brown Lane. Extensions are to be made to the works.

Leeds Chemical Cleaning Works Limited are to extend their works at Apperley Bridge.

Leicester. Ladies Pride Outerwear Limited, Benson Street are considering extensions.

London. AEI Cable Division. Work will shortly begin on a new high voltage laboratory at the Woolwich works of Associated Electrical Industries Limited, the estimated cost of which is over £400,000.

Loughborough. Johnson & Son. (Loughborough) Limited, Trinity Street. Extensions to works.

Manchester. Cussons Sons & Co. Limited are to extend their Kersal Vale Works, Broughton.

Mansfield. Mansfield Hosiery Mills Limited, Botany Avenue. Extensions to factory

Janfrey (Mansfield) Limited, Lindley Street are to make extensions to their factory.

Margate. Aligraphy Limited, are to erect a new factory at the Ramsgate Road industrial estate.

Nuneaton. Coventry Art Castings Limited, are to extend their factory at Caldwell Road.

Redditch. The British Aluminium Company Limited. Work has begun on the erection of a new toolroom with its own drawing office. This is the start of the final construction phase in a three-year development programme costing approximately £1,500,000 which will be completed by late 1962.

Sheffield. C. & J. Hampton Limited, Bernard Road. New factory.

Slough. M. J. Fecher Limited, Littlefield Lodge, 175 Bath Road are to build two new factories.

Southampton. Plenty & Son Limited, Cheap Street, Newbury. Extensions are to be made to Eastgate Metal Works.

Surbiton. J. L. Jameson Limited, Mount Road. Factory to be extended.

Swansea. Minnesota Mining & Manufacturing Company Limited, Gorseinon. The architects for the new factory are Sir Percy Thomas and Son, 104 Walker Road, Swansea.

West Bromwich. Fordath Engineering Company Limited, are to make extensions to their works at Brandon Way. The architect is C. E. M. Fillmore, Waterloo Street, Birmingham. 2.

Phoenix Tube Company Limited, Great Bridge Street. Extensions are to be made to the works.

Cumbernauld. Rubery Owen and Company Limited of Darlaston Staffs are to build a 100,000 sq ft factory at Blairlinn Industrial Estate, to manufacture components for the car industry at Linnwood and Bathgate.

East Kilbride. Standard Telephones and Cables Limited will build a major factory at College Milton Estate to employ 1000 workers on components for microwave equipment.

Paisley. Cochrane and Johnson Limited of Broomlands St., Paisley are building a new factory which will occupy 40,000 sq ft. Metal products will include nameplates, precision instruments and allied products.

Glenrothes. Cessna Products Limited, valve manufacturers, are to extend their premises adding 2000 to 3000 sq ft of manufacturing space.

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THE proprietor of British Patent Nos. 809520, 809518 and 809519, entitled "Safe torque drivers" and "Safety torque driver" and "Multi-roller safe torque drivers", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 140 So. Dearborn Street, Chicago 3, Illinois, U.S.A.

THE proprietor of British Patent Nos. 809847 and 809848, entitled "Safe torque nut setter" and "Safe torque drivers" offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 140 So. Dearborn Street, Chicago 3, Illinois, U.S.A.

THE proprietor of British Patent No. 630142, entitled "Method and apparatus for distilling carbonaceous material", offers same for license or otherwise to ensure practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, 140 So. Dearborn Street, Chicago 3, Illinois, U.S.A.

THE proprietors of Patent No. 761609 for "Electronic Device for the Operation of a Time Piece Movement". Desire to secure commercial exploitation by Licence or otherwise in the United Kingdom, Replies to Box No. H.W. 32 "MECHANICAL WORLD" 31, King Street West, Manchester, 3.

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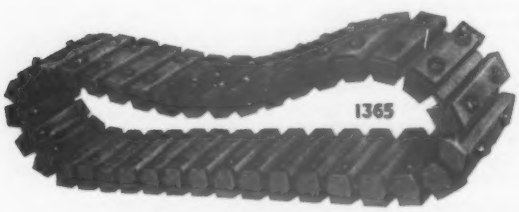

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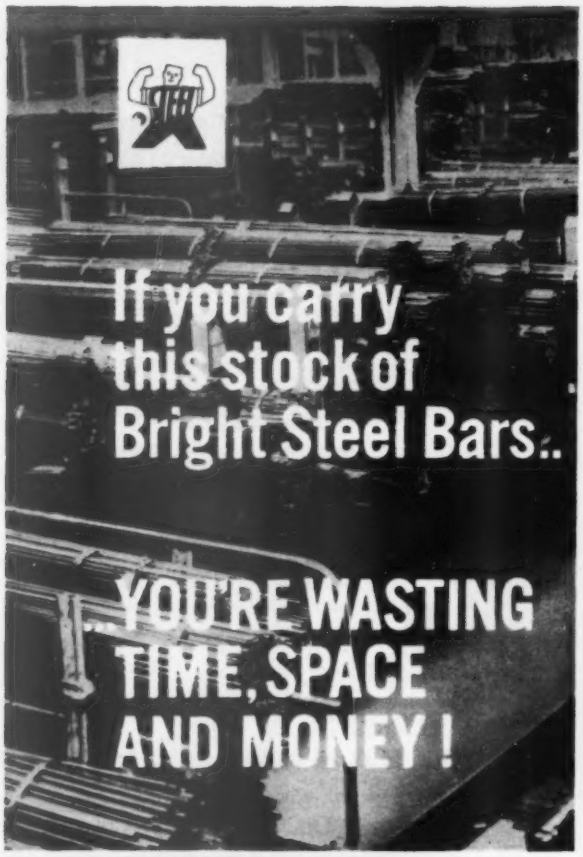

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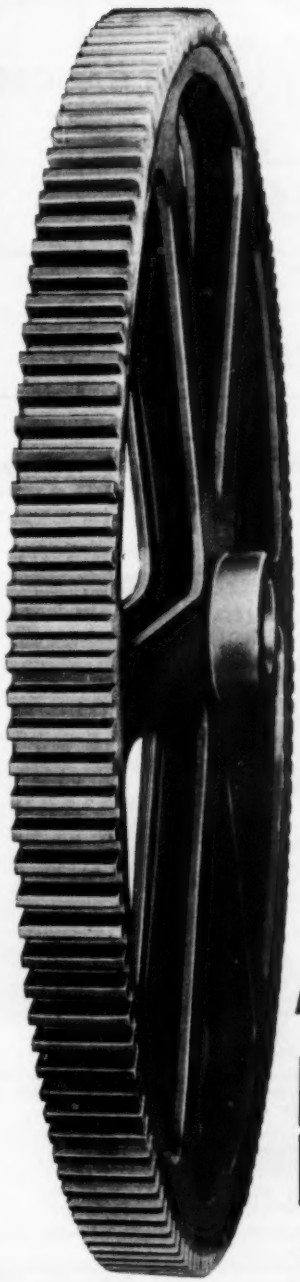

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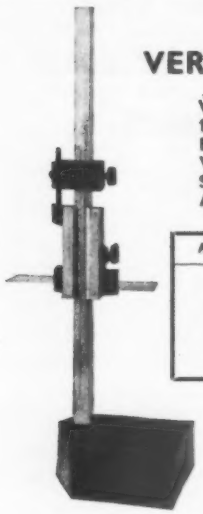

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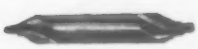

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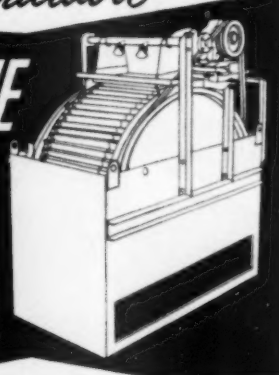

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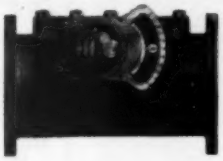

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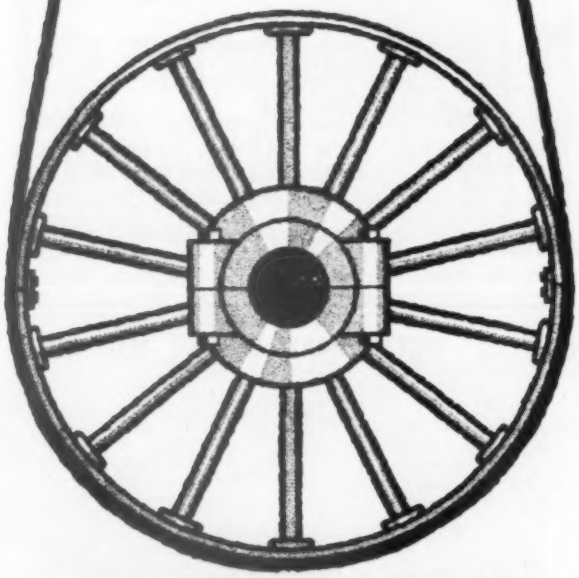

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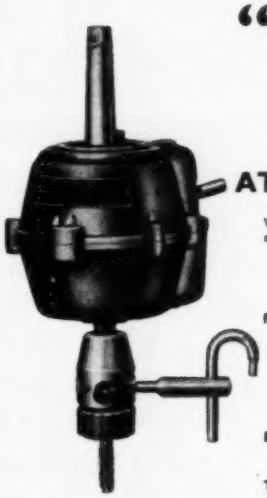

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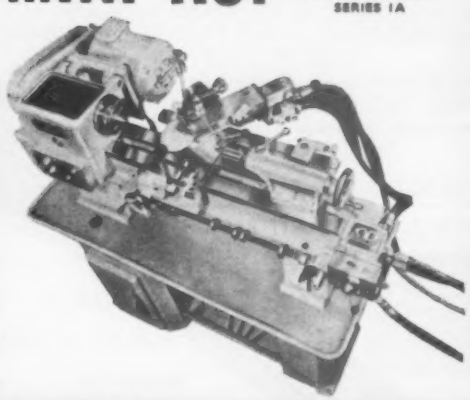

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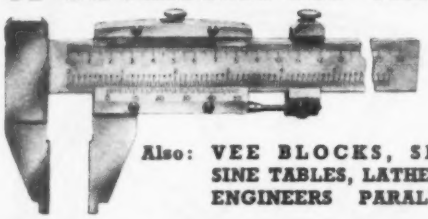

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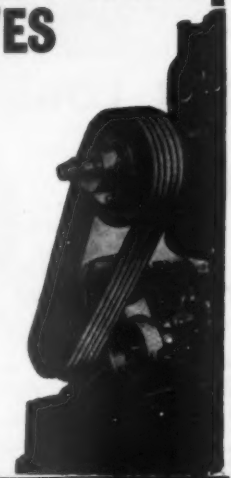

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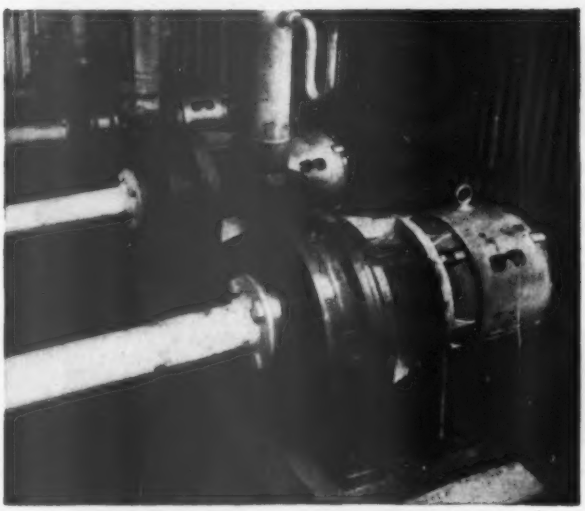

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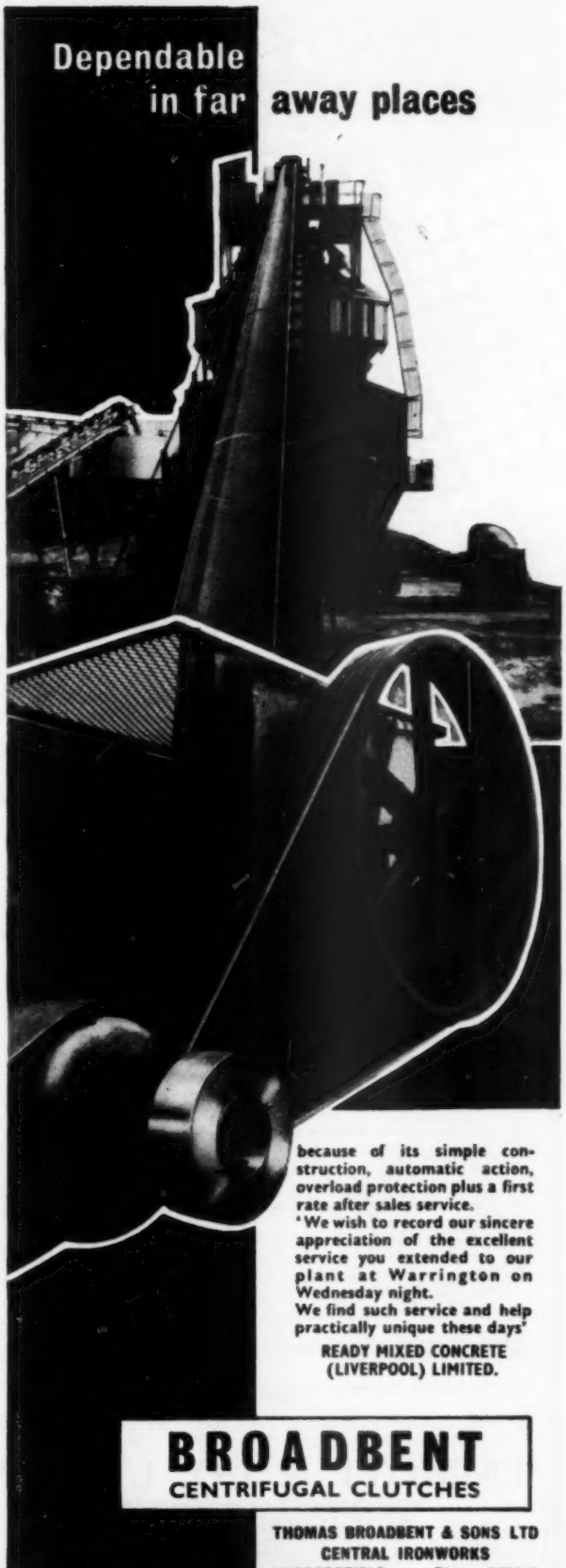

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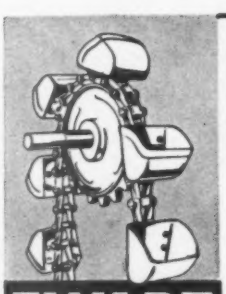

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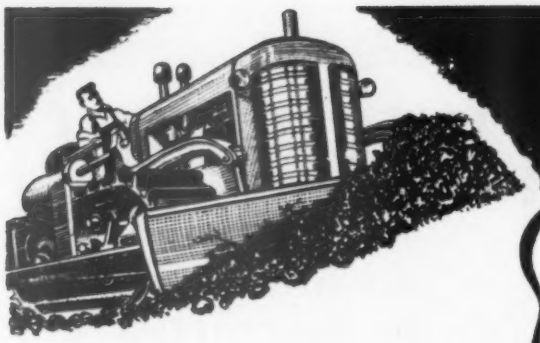

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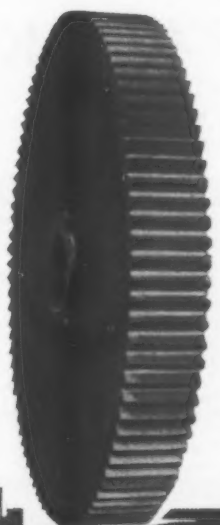

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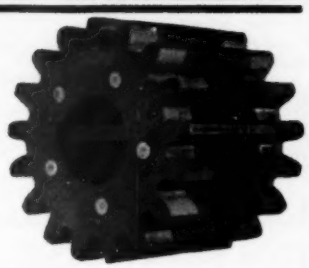

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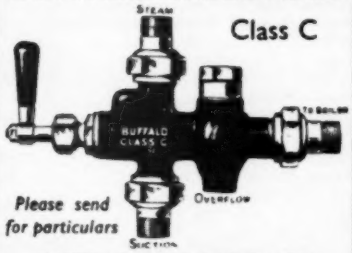

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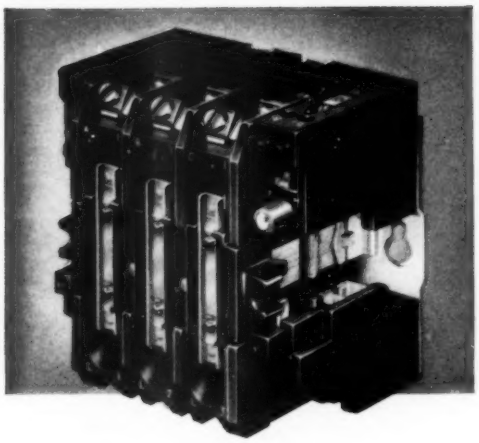

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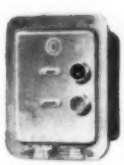

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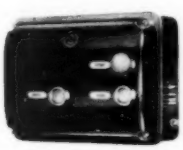

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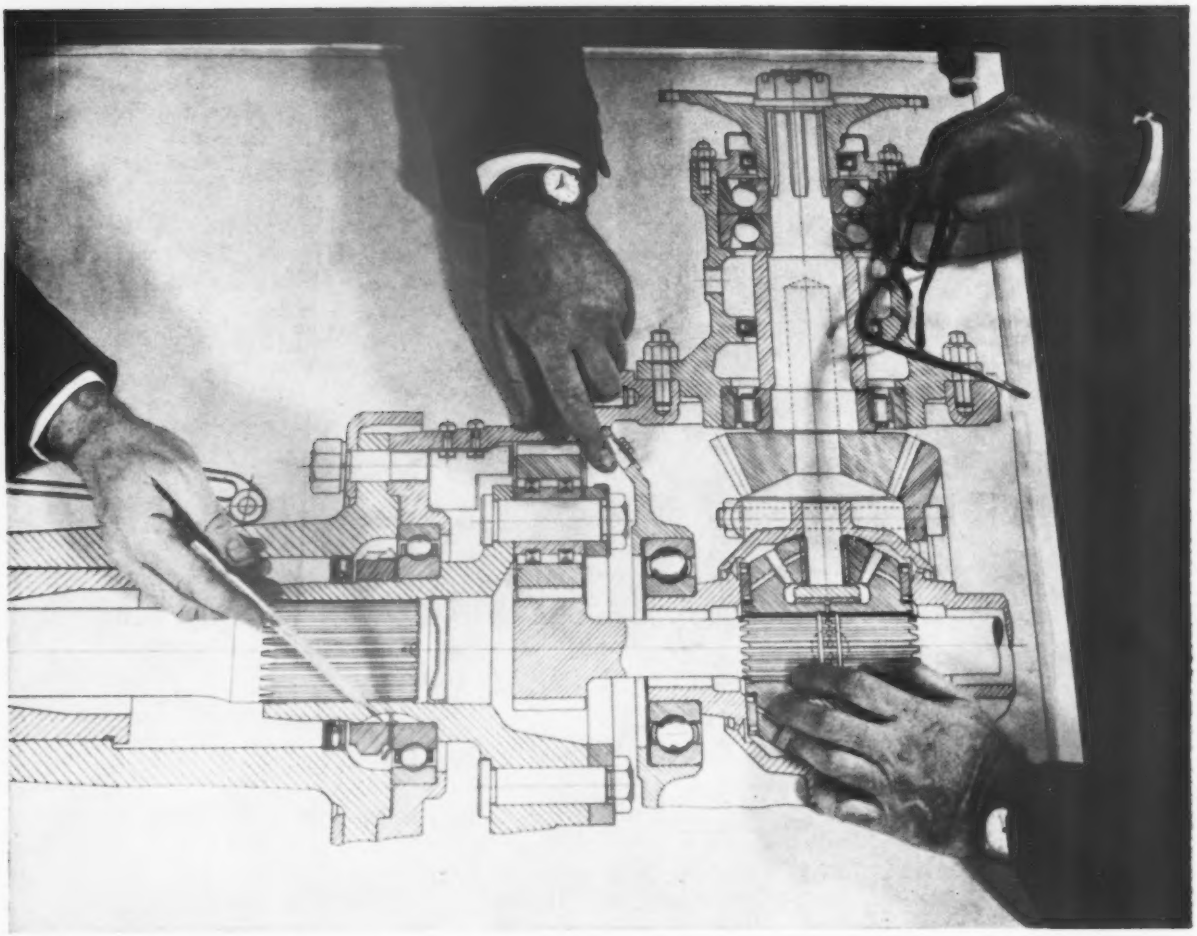

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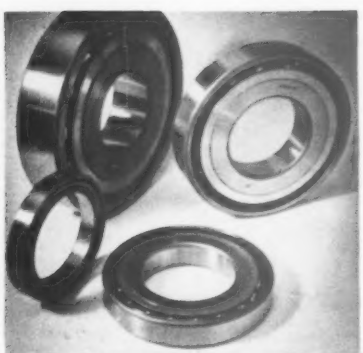

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